Atlantic Richfield Compar

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April 8, 2017

Ms. Lynda Deschambault
US EPA Region 9
75 Hawthorne Street; SFD-7-2
San Francisco, CA 94105

RE: 2016 Annual Completion Report
Channel Underdrain, Delta Seep, and Aspen Seep Water Treatment Activities
Leviathan Mine
Alpine County, California

Dear Ms. Deschambault:

On behalf of Atlantic Richfield Company, please find enclosed the *2016 Annual Completion Report – Channel Underdrain, Delta Seep, and Aspen Seep Water Treatment Activities* (Annual Report) prepared for the Leviathan Mine Site. This Annual Report meets the commitments made to the United States Environmental Protection Agency (U.S. EPA) in the *Removal Action Work Plan* (Atlantic Richfield; March 2013) and the requirements of the Administrative Settlement Agreement and Order on Consent for Removal Action (AOC) issued by U.S. EPA on January 21, 2009.

CERTIFICATION

As required in the draft AOC, we certify this report as follows:

"Under penalty of law, I certify that to the best of my knowledge, after appropriate inquiries of all relevant persons involved in the preparations of the report, the information submitted is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

If there is anyone else that should receive a copy of this report please let us know. In addition, if you have any questions or comments, please feel free to contact me at (657) 529-4537 or via e-mail at Anthony.Brown@bp.com.

Sincerely,

Anthony R. Brown

Tony Brown
Project Manager Mining

Enclosures: *2016 Annual Completion Report – Channel Underdrain, Delta Seep, and Aspen Seep Water Treatment Activities* (three hardcopies and one electronic copy on compact disc)

cc: Gary Riley, US EPA – via electronic
Doug Carey, Lahontan Regional Water Quality Control Board
Adam Cohen, Esq., Davis Graham & Stubbs LLP
Nathan Block, Esq., BP America, Inc. – via electronic
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2016 ANNUAL COMPLETION REPORT

Channel Underdrain, Delta Seep, and Aspen Seep Water Treatment Activities

Leviathan Mine Site
Alpine County, California

Atlantic Richfield Company

April 2017

2016 ANNUAL COMPLETION REPORT

Channel Underdrain, Delta Seep, and Aspen Seep Water Treatment Activities

Leviathan Mine Site
Alpine County, California

Prepared for:

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April 2017

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LIST OF ABBREVIATIONS AND ACRONYMS

AOC	Administrative Order on Consent
AD	acid drainage
Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure, Inc.
ARWS	Atlantic Richfield Work Season
AS	Aspen Seep
ASB	Aspen Seep Bioreactor
AST	Aboveground storage tank
Atlantic Richfield	Atlantic Richfield Company
BMP	best management practice
CCR	California Code of Regulations
CCV	continuing calibration verification
CEC	Copper Environmental Consulting
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	chain-of-custody
COW	Control of Work
CUD	Channel Underdrain
cy	cubic yard
DO	dissolved oxygen
DQO	data quality objective
DS	Delta Seep
DST	Delta Seep Transfer
ELAP	Environmental Laboratory Accreditation Program
ESI	Environmental Standards, Inc.
ft	feet
FTP	file transfer protocol
gpd	gallons per day
gpm	gallons per minute
g/L	grams per liter
H_2S	hydrogen sulfide
HDPE	high-density polyethylene
HDS	High Density Sludge
HMI	Human Machine Interface
HSSE	Health, Safety, Security, and Environment
ICT	Interim Combined Treatment
iVFD	intelligent variable frequency drive
LAS	Limited Access Season
Lbs	pounds
LCP	local control panel
LEL	lower explosive limit
LRWQCB	Lahontan Regional Water Quality Control Board
LTF	lagoon treatment facility

LTS	lime treatment system
MDL	method detection limit
mg/L	milligrams per liter
mL/L	milliliters per liter
mL/min	milliliters per minute
MoC	Management of Change
MRAM	Modification to the Removal Action Memorandum
MS/MSD	matrix spike/matrix spike duplicate
mV	millivolts
NaOH	sodium hydroxide
O&M	operations and maintenance
ORP	oxidation/reduction potential
OSHA	Occupational Safety and Health Administration
PLC	programmable logic controller
PPE	Personal Protective Equipment
ppm	parts per million
PSD	Protective System Device
PUD	Pit Underdrain
PVC	Polyvinyl chloride
PWTF	Pond Water Treatment Facility
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RAWP	Removal Action Work Plan
RCRA	Resource Conservation and Recovery Act
RCTS	Rotating Cylinder Treatment System
RI/FS	Remedial Investigation/Feasibility Study
RL	reporting limit
RM	Remediation Management
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SCADA/WIN-911	supervisory control and data acquisition
SDB	sludge drying bed
Site	Leviathan Mine Site
SOP	Standard Operating Procedure
SPLP	synthetic precipitation leaching procedure
SR 89	California State Route 89
SRB	sulfate-reducing bacteria
STLC	soluble threshold limit concentration
s.u.	standard units
TCLP	toxicity characteristic leaching procedure
TestAmerica	TestAmerica Laboratories, Inc.
TSHASP	Task Specific Health and Safety Plan
TSP	trisodium phosphate

TTLC	total threshold limit concentration
UPCS	Upper Ponds Conveyance System
US 395	U.S. Highway 395
USDA	United States Department of Agriculture
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VFD	variable frequency drive

EXECUTIVE SUMMARY

This *2016 Annual Completion Report: Channel Underdrain, Delta Seep, and Aspen Seep Water Treatment Activities* (Annual Report) has been prepared by Copper Environmental Consulting (CEC), on behalf of Atlantic Richfield Company (Atlantic Richfield) to describe the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response actions conducted at the Leviathan Mine Site (site) in 2016. Specifically, this Annual Report serves as a summary to document the completed 2016 water treatment related activities and other work relating to discharges from the Channel Underdrain (CUD), Delta Seep (DS), and Aspen Seep (AS) at the site.

The Annual Report has been prepared to meet the requirements of the Administrative Settlement Agreement and Administrative Order on Consent (AOC) for Removal Action, CERCLA Docket No. 2008-29 (U.S. EPA, 2009), as modified by CERCLA Docket No. 2008-29(a) (U.S. EPA, 2013). Additionally, the Annual Report meets the commitments made by Atlantic Richfield in Section 6.1 of the *Removal Action Work Plan* (RAWP) submitted to the U.S. Environmental Protection Agency (U.S. EPA) in March 2013 (Atlantic Richfield, 2013a) including amendments.

The following is a list of Removal Action water treatment-related activities completed at the site in 2016:

- Spring commissioning, operation, maintenance and winterization of the High Density Sludge (HDS) Treatment System utilized to capture and treat flows from the CUD and DS for discharge to Leviathan Creek;
- Removal of HDS Treatment System treatment-generated solids (sludge);
- Operation and maintenance of the Aspen Seep Bioreactor (ASB) Treatment System to treat flows from the AS for discharge to the aeration channel leading to Aspen Creek; and
- Removal of ASB Treatment System sludge.

During 2016, approximately 5.05 million gallons of water from the CUD and 2.18 million gallons of water from the DS were captured and treated by the HDS Treatment System. Approximately 609,000 gallons of water was collected directly in Pond 4 (not from the CUD or DS) over the 2015-2016 winter season. Approximately 50.5 tons of sludge (approximately 26% solids) produced from HDS Treatment System operations was dewatered in lined filter bins and removed from the site for appropriate disposal. Sludge generated by the HDS Treatment System was classified as non-hazardous waste according to Resource Conservation and Recovery Act (RCRA) regulations and non-RCRA hazardous waste according to California regulations.

During 2016, approximately 2.10 million gallons of water from the AS were treated by the ASB Treatment System. Approximately 13.5 tons of sludge (at an average of 12% solids) produced at the ASB Treatment System was dewatered in lined filter bins and removed from the site for appropriate disposal. Sludge generated by the ASB Treatment System was classified as non-hazardous waste according to RCRA and California regulations.

All sludge was characterized, profiled, and transported under manifest to US Ecology, Inc., in Beatty, Nevada, for disposal.

Spring commissioning of the HDS Treatment System was initiated on April 5, 2016. HDS Treatment System operations commenced on May 10, 2016 and continued through October 12, 2016. CUD and DS conveyance flows were captured from May 16, 2016 through October 12, 2016.

The ASB Treatment System operated year-round in 2016 with minor interruptions occurring occasionally throughout the year.

In addition to the above-mentioned water treatment activities, the following activities were completed at the site in 2016:

- Community relations, including participating in Technical Summary Meeting, stakeholder review and comments on documents prepared for the site, and maintaining project information repositories and public information sites.
- Performance monitoring of the HDS and ASB Treatment Systems, including sampling and analysis of water and sludge.
- Additional HDS Treatment System evaluations and improvements, including stainless steel pipe upgrades in CUD, DS, and Delta Seep Transfer (DST) conveyance tanks, conveyance pump variable frequency drive upgrades, installation of temperature switches in conveyance control panels, and testing lime screw feeder speed modifications.
- Additional ASB Treatment System evaluations and improvements, including Pond 4 stair replacement, solids management, hydrogen gas alarm upgrades, drainage improvements in the AS collection area, ethanol dosing improvements, and propane generator engine replacement.
- Road maintenance on both the California and Nevada access portions of Leviathan Mine Road, including grading and subsurface maintenance, road stability monitoring, drainage maintenance, and dust suppression.
- Road maintenance at the HDS Treatment System, including grading and dust suppression.
- Boulder removal near the AS access gate to improve safe access to the site.
- Stormwater best management practice (BMP) maintenance, including cleaning/restoring drainage ditches and cleaning/clearing culverts.
- Construction of the Upper Ponds Conveyance System (UPCS) to convey water from the Pond 1 and Pond 2S to facilitate Interim Combined Treatment (ICT) using the HDS

Treatment System was initiated during 2016. Construction activities will be completed during 2017.

In addition to descriptions of water treatment-related response actions and performance monitoring results, this report also includes summary information on costs incurred by Atlantic Richfield during 2016 in complying with the AOC.

1.0 INTRODUCTION

This *2016 Annual Completion Report: Channel Underdrain, Delta Seep, and Aspen Seep Water Treatment Activities* (Annual Report), has been prepared by Copper Environmental Consulting (CEC), on behalf of Atlantic Richfield Company (Atlantic Richfield) to describe the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response actions conducted at the Leviathan Mine Site (site) in 2016. Specifically, this Annual Report serves as a summary to document the completion of 2016 water treatment activities and other work relating to discharges from the Channel Underdrain (CUD), Delta Seep (DS), and Aspen Seep (AS) at the site.

This Annual Report has been prepared to meet the requirements of the *Administrative Settlement Agreement and Order on Consent (AOC) for Removal Action, CERCLA Docket No. 2008-29/2008-29(a)* (U.S. EPA, 2009, 2013), paragraph 63. Additionally, the Annual Report meets the commitments made by Atlantic Richfield in Section 6.1 of the *Removal Action Work Plan* (RAWP) submitted to the U.S. Environmental Protection Agency (U.S. EPA) in March 2013 (Atlantic Richfield, 2013a) including amendments.

The Annual Report also meets the commitments made by Atlantic Richfield in the following documents:

- *Request for Authorization to Perform Water Treatment During the 2016 Spring Portion of the Limited Access Season, High Density Sludge Treatment System, Leviathan Mine, Alpine County, California*; dated March 20, 2016 (Atlantic Richfield; 2016c). This letter requested U.S. EPA authorization for Atlantic Richfield to perform activities related to access, High Density Sludge (HDS) Treatment System spring commissioning, and the collection and treatment of CUD and DS flows during the spring 2016 Limited Access Season (LAS), and was approved by U.S. EPA by email on April 13, 2016.
- *Amendment No. 2016- 01 – 2016 Annual Amendment, RAWP, Leviathan Mine, Alpine County, California*; dated February 29, 2016 (Atlantic Richfield; 2016a). This amendment notified U.S. EPA of updates and work-related tasks to be performed in 2016 that differed from or were done in addition to those set forth in the RAWP. The RAWP amendment was approved by U.S. EPA on April 8, 2016.
- *Request for Approval of Fall 2016 LAS Operations, and 2016 Year-End Decommissioning and Winterization Plan, Leviathan Mine, Alpine County, California*; dated September 21, 2016 (Atlantic Richfield; 2016f). This letter requested U.S. EPA authorization for Atlantic Richfield to operate the HDS Treatment System beyond the 2016 Atlantic Richfield Work Season (ARWS) and presented plans for decommissioning and winter preparation of the HDS Treatment System, and was approved by U.S. EPA by email on September 21, 2016.

Note: The AOC defines the ARWS as the period from June 1 through September 30, and the LAS as the period from October 1 through May 31, during each year the AOC remains in effect, unless modified in writing by the U.S. EPA and Atlantic Richfield.

1.1 Report Objectives and Scope

This Annual Report was prepared to meet the following objectives and scope:

- Provide a summary of the treatment-related activities conducted in 2016;
- Provide a tabulation of the validated data collected in 2016 as part of the treatment activities and accompanying laboratory data sheets;
- Summarize health and safety performance during 2016;
- Provide an interpretation of the data to evaluate treatment system performance during 2016;
- Provide a listing of Waste Materials (as defined in the AOC) moved off-site or handled on-site, a discussion of removal and disposal options considered for these materials, a listing of the destination(s) of these materials, a presentation of the analytical results of all sampling and analysis performed, and accompanying appendices containing all relevant documentation generated during the Removal Action;
- Provide a summary of support/system improvement activities conducted in 2016; and
- Summarize the costs incurred in 2016.

Additionally, this report includes site background information, including descriptions of the CUD, DS, AS, and Removal Action activities previously performed at these locations.

This annual completion report also briefly describes the Upper Ponds Conveyance System (UPCS) construction activities completed during 2016.

1.2 Purpose of the Removal Action

The purpose of the Removal Action at the site is to satisfy the requirements of the AOC, including treatment of collected flows from the CUD, DS, and AS. The water treatment activities also provide important operational information that may be used in formulating a final, long-term remedy for the site consistent with the Remedial Investigation/Feasibility Study (RI/FS) process. As such, water treatment activities implemented by Atlantic Richfield in 2016 were intended to investigate the cost, effectiveness, and implementability of the treatment technologies and solids management measures employed at the site. The 2016 treatment activities water quality goals were consistent with the discharge criteria presented in the *Non-Time Critical Removal Action Memorandum* for the site, as modified by the U.S. EPA in the *Modification to the Removal Action Memorandum* (MRAM; U.S. EPA, 2008), dated September 25, 2008, which restated the discharge criteria. The MRAM discharge criteria are listed with a summary of the analytical data for the HDS and the Aspen Seep Bioreactor (ASB) Treatment Systems in Tables 2 and 3, respectively.

The 2016 treatment activities included the following general activities:

- Spring commissioning, operation and maintenance, and winterization of the HDS Treatment System to capture and treat flows from the CUD and DS for discharge to Leviathan Creek;
- Removal of HDS Treatment System treatment-generated solids (sludge);
- Operation of the ASB Treatment System to treat flows from the AS for discharge to the aeration channel leading to Aspen Creek; and
- Removal of ASB Treatment System sludge.

All response actions performed by Atlantic Richfield at or related to the site were conducted pursuant to U.S. EPA orders and in accordance with work plans, work plan amendments, or other authorization requests submitted to and approved by the U.S. EPA. All response actions described in this report related, either directly or indirectly, to the collection and treatment of acid drainage (AD) at the CUD, DS, and AS.

1.3 Health, Safety, Security, and Environment Expectations

Atlantic Richfield is fully committed to its health, safety, security, and environment (HSSE) goals, which are *no accidents, no harm to people, and no damage to the environment*. Atlantic Richfield values these HSSE goals because it is committed to the health, safety, and security of people; the safety of the communities in which it operates; and the protection of the natural environment. Accordingly, Atlantic Richfield has an expectation that everyone who works for them has a responsibility for getting HSSE right. To achieve and promote these expectations, Amec Foster Wheeler Environment and Infrastructure, Inc. (Amec Foster Wheeler) prepared the *Leviathan Mine Site Health, Safety, Security, and Environment Program Document* (HSSE Program Document; Atlantic Richfield, 2016b), which is the site-wide occupational health and safety guidance document for Atlantic Richfield and their contractors, subcontractors, and visitors working at or visiting the site.

The HSSE Program Document describes the Atlantic Richfield Control of Work (COW) procedures, identifies the general potential physical and chemical hazards that may be encountered, outlines emergency response procedures, and specifies the requirements for contractor health and safety at the site. The HSSE Program Document is updated annually and as conditions change or new information becomes available.

Additionally, all contractors working at the site are responsible for preparing a Task Specific Health and Safety Plan (TSHASP) specific to their company's HSSE Management Program and site specific scope of work, authorities, and responsibilities. The TSHASPs contain information necessary for the more specific day-to-day HSSE management and are used in conjunction with the HSSE Program Document.

Each person who performs work at the site as an Atlantic Richfield employee, contractor, subcontractor, or visitor is expected to read and acknowledge understanding of the current HSSE Program Document and applicable TSHASPs, Atlantic Richfield Remediation

Management's (RM's) COW Defined Practices and HSSE expectations, and participate in a process of continuous health and safety improvement.

1.4 Report Organization

The remainder of this report is organized into the following sections:

- Section 2 - Site Background Information: summarizes the physical setting of the site , descriptions of the treatment systems, and the history of Atlantic Richfield's Removal Action activities.
- Section 3 - Health and Safety Performance and Community Relations: summarizes the health and safety performance and community relations activities conducted for the site in 2016.
- Section 4 - 2016 Removal Action Activities: describes the objectives and details of the water treatment activities, related response actions completed to improve site safety and to support more efficient and reliable water treatment activities, and summarizes the materials removed from the site in 2016.
- Section 5 - 2016 Monitoring Activities: describes the monitoring activities conducted at the site in 2016, including data quality objectives (DQOs), sampling and analysis activities, and quality assurance (QA)/quality control (QC) measures.
- Section 6 - 2016 Monitoring Results: describes the results of the monitoring activities conducted at the site in 2016, including treated volume and flow rates, sampling and analysis results, and system performance.
- Section 7 - 2016 Site Maintenance Activities: provides a summary of the site maintenance activities conducted in 2016, including general Pond 4 activities and road maintenance.
- Section 8 - Statement of Costs Incurred: provides a summary of costs incurred during 2016.
- Section 9 - 2016 UPCS Construction Activities: provides a summary of the UPCS construction activities completed in 2016.
- Section 10 - References: provides a listing of references cited.

2.0 SITE BACKGROUND INFORMATION

This section presents relevant site background information, including a description of the site location and physical setting and a history of past treatment activities.

2.1 Site Location, Physical Setting, and Watershed Descriptions

The site is a former copper and open-pit sulfur mine in an unpopulated area of Alpine County, California, that is surrounded by Toiyabe National Forest. The site is located approximately 20 miles south of Gardnerville, Nevada, approximately four miles west of the California/Nevada border, and approximately seven miles east of Markleeville, California.

The site is accessible via a gravel road, known as both Leviathan Mine Road and Forest Service Road 10052. Leviathan Mine Road/Forest Service Road 10052 intersects U.S. Highway 395 (US 395) approximately 10 miles south of Gardnerville, Nevada and trends southwest approximately 14 miles where it connects with California State Route 89 (SR 89), approximately three miles west of Monitor Pass. The site is located on Leviathan Mine Road, approximately 11 miles from US 395 and three miles from SR 89, as shown on the site location map (Figure 1).

The site is located on the eastern flank of the Sierra Nevada, which is situated near the western margin of the Basin and Range geologic province. The topography is mountainous; elevations within the fenced portions of the site range from approximately 6,900 to 7,400 feet (ft) above mean sea level. Elevations within the surrounding watershed exceed 8,000 ft above mean sea level. The region is seismically active and classified as a Seismic Zone 4.

The site lies within the Bryant Creek watershed of the Carson River Basin. Surface water at the site flows into Nevada and the internal Great Basin watershed via tributaries of the East Fork of the Carson River. Specifically, Leviathan Creek flows through the site. Aspen Creek discharges into Leviathan Creek approximately a quarter mile downstream from the site. Leviathan Creek converges with Mountaineer Creek approximately two miles downstream of the site to form the headwaters of Bryant Creek. Bryant Creek flows approximately 7.5 miles before connecting with the East Fork of the Carson River.

2.2 Overview of Past Treatment Activities

According to the U.S. EPA, and based on available data, five flows or discharge areas contribute the majority of AD loading to the surface water at the site. These AD sources include the following:

- The Adit;
- Pit Underdrain (PUD);
- CUD;

- DS; and
- AS.

The locations of these sources are shown on the site map presented as Figure 2. Water treatment activities related to discharges from the CUD, DS, and AS are summarized in this report. Discharges from the Adit and PUD are being addressed separately by the Lahontan Regional Water Quality Control Board (LRWQCB) under a *U.S. EPA Administrative Abatement Action, CERCLA Docket No. 2005- 15.* A chronology and summary of prior response actions conducted by Atlantic Richfield are presented below.

2.2.1 Pond 4 Treatment Area, CUD, and DS

The Pond 4 treatment area has historically been used to treat flows from the CUD and DS typically from May through October. The following features are important to treatment activities at the Pond 4 area:

- **CUD** - The CUD collects and discharges subsurface water year-round, at a flow rate which has ranged from approximately 6 to 45 gallons per minute (gpm) in recent years, from beneath the concrete Leviathan Creek diversion channel and underground pipelines.
- **DS** - The DS produces a flow year-round, at a flow rate which has historically ranged between approximately 5 and 30 gpm. The DS originates from the lowest topographic portion of the mine waste rock in the Leviathan Canyon, located approximately 600 ft downstream from the end of the Leviathan Creek concrete diversion channel and the CUD outlet. The DS is visible as both an upper and lower seep.
- **Pond 4 Treatment Area** The Pond 4 treatment area is where collected CUD and DS flows are treated and discharged into the Leviathan Creek diversion channel typically from May through October. The Pond 4 treatment area has generally consisted of Pond 4, varying types of treatment systems, and power generation systems.

The following summarizes activities conducted during previous years to address flows from the CUD and DS:

2001 – In 2001, a short-term, continuous lime addition treatment system designed for metal hydroxide and metal oxy-hydroxide precipitation was implemented. The treatment system, constructed in 2001, was referred to as the Lagoon Treatment Facility (LTF), which treated CUD waters between August 2 and October 1 at Pond 4. The LTF demonstrated the effectiveness of lime treatment with metal concentrations of treated discharge water below the site discharge criteria.

2002 – The LTF was re-established to treat the CUD water as it did at the end of 2001. The LTF operated successfully between June and November. A total of approximately 3.2 million gallons of CUD water were treated during 2002. Changes made to the lime delivery system resulted in better process control and fewer difficulties with clogging of the lime pumps. Water quality monitoring in Leviathan Creek showed higher pH readings and reduced metals concentrations downstream of the CUD discharge location during the time CUD water was being collected and treated by the LTF.

At the end of November 2002, a four-day study was conducted to determine the feasibility of treating combined flows from the CUD, DS, Adit, and PUD sources. System additions to accomplish this study included a capture-and-pump system for transportation of the DS water to the location of the CUD collection tank; a pumping system to transport the combined CUD and DS waters to the LRWQCB Pond Water Treatment Facility (PWTF) located near Pond 1 (Figure 2); and plumbing modifications to the PWTF. The PWTF effectively treated the combined flow prior to discharge into Pond 4; however, it was reported that extended operation would be required to accurately determine the reliability of the process.

2003 – The 2003 treatability activities focused on evaluating and optimizing the use of the PWTF for combined flow treatment. Two phases of combined flow treatment using the PWTF were conducted. The first phase was conducted from June 18 through July 29. The second phase was conducted from August 18 through September 29. From July 18 through August 18, the PWTF was only used for treatment of evaporation Pond water (collected Adit and PUD flows). During this time, flows from the CUD and DS were diverted from Leviathan Creek and the LTF was re-assembled and used to treat the CUD and DS discharges. Between July 21 and August 20 approximately 1.5 million gallons of CUD and DS waters were treated and discharged to Leviathan Creek. Results of the PWTF for combined flow treatment and the LTF treatability study showed that both systems were effective in reducing the concentrations of dissolved metals below site discharge criteria.

2004 – In 2004, the LTF was reassembled and initially used to treat the CUD and DS waters. Subsequently, the LTF was taken offline and a rotating cylinder treatment system (RCTS) was implemented and evaluated for treating the combined CUD and DS waters. The design concept of the RCTS differs from the deep tank designs of conventional lime treatment systems (LTS) such that it uses shallow trough-like cells for mixing the impacted waters and lime by rotating cylinders for improved aeration and agitation during treatment of the water. During the 2004 treatment period, approximately 4.9 million gallons of CUD and DS waters were treated and discharged to Leviathan Creek. The 2004 laboratory analytical results indicated that a majority of the treated discharge concentrations of dissolved metals were below effluent discharge criteria.

2005 – In 2005, a pilot program to evaluate HDS treatment technology was conducted for treatment of CUD water. The DS water was not collected and treated due to logistical and safety concerns related to Delta Slope stabilization activities performed by the LRWQCB between June and October, [1] including installation of a drain intended to collect surface water runoff from the slope.

The HDS technology is based on the traditional lime neutralization method, but additionally involves recycling a portion of the sludge from a clarifier to further increase the sludge density and draining properties, and to reduce sludge volume. From July 27 through September 30, approximately 2.9 million gallons of CUD waters were treated and discharged to Leviathan Creek. The 2005 laboratory analytical results indicated that a majority of the treated discharge concentrations of dissolved metals were below effluent discharge criteria.

2006 – In 2006, the CUD was collected and treated using the same HDS technology as in the 2005 pilot program. Treatment of the CUD began on July 19 and was temporarily discontinued on August 25 in preparation for the transition to another treatment system, then under construction. During this time, approximately 1.9 million gallons were treated and discharged to Leviathan Creek. From September 2 through October 20, the CUD was collected and treated using an interim lime-neutralization treatment system or LTF system. The LTF system was similar to the 2004 LTF. During this period, approximately 2.0 million gallons were treated and discharged to Leviathan Creek. The DS was not collected in 2006 for the reasons described above for 2005.

2007 – In 2007, approximately 2.9 million gallons of CUD water were collected from June 15 to October 10 using a modified version of the 2006 collection system. Approximately 660,000 gallons of DS water were collected continuously from June 29 to October 10, with a suspension (approved by the U.S. EPA) from September 14 through September 25. From June 19 to October 10, a newly constructed Pond 4 LTS using RCTS technology was used to treat collected CUD and DS flows as well as approximately 400,000 gallons of water existing in Pond 4 at the beginning of the treatment season. Approximately 56.7 tons of non-hazardous sludge generated from the 2006 LTF and approximately 45.2 tons of non-hazardous sludge generated from the 2007 LTS were disposed of during the summer and fall 2007 at US Ecology in Beatty, Nevada.

Additionally, while the temporary LTS was being used to treat CUD and DS flows, the HDS Treatment System was being designed and planned for construction in 2008. In 2007, a process building for the planned HDS Treatment Plant was designed, constructed, and erected. Semi-permanent collection and conveyance equipment for CUD and DS were also designed, constructed, and completed in 2007.

2008 – In 2008, approximately 4.4 million gallons of CUD water and 1.3 million gallons of DS water were collected from May 28 to October 9. Both the CUD and DS were collected using the semi-permanent collection and conveyance equipment that was constructed in the fall of 2007.

[1] Surface water runoff from a thunderstorm on August 12, 2004, triggered a landslide that buried the DS collection system. Atlantic Richfield issued a no-entry into the DS area until slope stabilization and a geotechnical evaluation of the slope were completed.

From May 30 to October 9, the Pond 4 LTS using the RCTS (constructed in 2007) was used to treat collected CUD and DS flows as well as approximately 300,000 gallons of water existing in Pond 4 at the beginning of the treatment season. In the fall of 2008, approximately 56 tons of non-hazardous sludge generated from the 2008 LTS was disposed of at US Ecology in Beatty, Nevada.

While flows from the CUD and DS were treated with the Pond 4 LTS, construction of the HDS Treatment System (including the CUD and DS collection and conveyance equipment; power generation system; and electrical controls, and instrumentation systems) was initiated on May 12 and continued through September 2008. Once the HDS Treatment System was constructed, testing and pre-commissioning activities commenced. A detailed description of the HDS Treatment System is provided in Section 4.2.2. These activities included the inspection and initial testing of instrumentation, input/output controls, pumps, the generator system, the fuel supply system, the lime system, the flocculent mixing/addition system, the aeration blower system, and the clarifier. In October, the HDS Treatment System was winterized as it was planned to be commissioned in 2009.

2009 – In 2009, approximately 5.1 million gallons of CUD water and 1.9 million gallons of DS water were collected from May 1 to October 30. From May 1 to July 15, the Pond 4 LTS using the RCTS (constructed in 2007) was used to treat CUD and DS flows as well as approximately 286,000 gallons of water existing in Pond 4 at the beginning of the treatment season. The volume of stored water in Pond 4 was reduced to the greatest extent possible using the Pond 4 LTS.

While flows from the CUD and DS were treated with the Pond 4 LTS, pre-commissioning activities were re-initiated at the HDS Treatment System. On July 20, the HDS Treatment System was commissioned and Pond 4 was converted from a clarifying pond to an untreated equalization pond. From July 20 to November 1, the HDS Treatment System, including the CUD and DS collection and conveyance equipment was used to treat approximately 3.3 million gallons of CUD and DS flows. Approximately 75 tons of non-hazardous sludge produced from 2009 Pond 4 LTS operations and dewatered via filter bags, and 11 tons of non- Resource Conservation and Recovery Act (RCRA) California hazardous waste solid (sludge) produced from the HDS Treatment Plant operations, were disposed of at US Ecology in Beatty, Nevada. The HDS Treatment Plant was effective at treating impacted CUD and DS water to below the site discharge criteria, used less hydrated dry lime, and produced a lower volume of sludge per the same volume of water than the Pond 4 LTS. The Pond 4 LTS was decommissioned on July 16 , 2009.

2010 – In 2010, approximately 7.4 million gallons of CUD water and 3.2 million gallons of DS water were collected. Flows from the CUD and DS were captured from May 6 to November 1. Capture of CUD flows resumed on November 5, and ceased on November 9 to utilize residual lime in the lime storage hopper prior to winterization activities. The HDS Treatment Plant treated and discharged approximately 11 million gallons to Leviathan Creek.

Spring commissioning activities were initiated at the HDS Treatment System on April 12. The HDS Treatment System was commissioned on April 28 and operated from May 1 through November 11 to treat flows from the CUD and DS, as well as approximately 431,000 gallons of water existing in Pond 4 at the beginning of the treatment season that had collected during the previous winter. The volume of stored water in Pond 4 was reduced to the lowest extent possible using the HDS Treatment System prior to winter shutdown.

Approximately 53 tons of non-RCRA California hazardous waste solid (sludge) produced from the HDS Treatment Plant was disposed of at US Ecology in Beatty, Nevada. The HDS Treatment Plant was effective at treating impacted CUD and DS water to below the site discharge criteria.

2011 – In 2011, approximately 10.2 million gallons of CUD water and 3.6 million gallons of DS water were collected. Flows from the CUD and DS were captured from May 13 to November 2. The HDS Treatment Plant treated and discharged approximately 13.1 million gallons to Leviathan Creek.

Spring commissioning activities were initiated at the HDS Treatment System on April 18. The HDS Treatment System was commissioned on April 25 and operated from May 13 through November 2 to treat flows from the CUD and DS, as well as approximately 682,000 gallons of water existing in Pond 4 at the beginning of the treatment season that had collected during the previous winter. The volume of stored water in Pond 4 was reduced to the lowest extent possible using the HDS Treatment System prior to winter shutdown.

Approximately 138 tons of non-RCRA California hazardous waste solid (sludge) produced from the HDS Treatment Plant was disposed of at US Ecology in Beatty, Nevada. The HDS Treatment Plant was effective at treating impacted CUD and DS water to below the site discharge criteria.

2012 - In 2012, approximately 5.0 million gallons of CUD water and 2.0 million gallons of DS water were collected. Flows from the CUD and DS were captured from April 27 to October 24, with a brief interruption from May 1 to May 3. The HDS Treatment Plant treated and discharged approximately 6.6 million gallons to Leviathan Creek.

Spring commissioning activities were initiated at the HDS Treatment System on April 9. The HDS Treatment System was commissioned on May 3 and operated through October 27 to treat flows from the CUD and DS, as well as approximately 300,000 gallons of water existing in Pond 4 at the beginning of the treatment season that had collected during the previous winter. The volume of stored water in Pond 4 was reduced to the lowest extent possible using the HDS Treatment System prior to winter shutdown.

Approximately 20 tons of non-RCRA California hazardous waste solid (sludge) (45% solids) produced from the HDS Treatment Plant was disposed of at US Ecology in Beatty, Nevada. The HDS Treatment Plant was effective at treating impacted CUD and DS water to below the site discharge criteria.

2013 – In 2013, approximately 5.0 million gallons of CUD water and 1.9 million gallons of DS water were collected. Flows from the CUD and DS were captured from May 8 to October 31, 2013. The HDS Treatment Plant treated and discharged approximately 5.8 million gallons to Leviathan Creek.

Spring commissioning activities were initiated at the HDS Treatment System on April 10. The HDS Treatment System was commissioned on May 10 and operated through October 31 to treat flows from the CUD and DS, as well as approximately 200,000 gallons of water existing in Pond 4 at the beginning of the treatment season that had collected during the previous winter. The volume of stored water in Pond 4 was reduced to the lowest extent possible using the HDS Treatment System prior to winter shutdown.

Approximately 13.8 tons of non-RCRA California hazardous waste solid (sludge) (42% solids) produced from the HDS Treatment Plant was disposed of at US Ecology in Beatty, Nevada. The HDS Treatment Plant was effective at treating impacted CUD and DS water to below the site discharge criteria.

2014 – In 2014, approximately 2.6 million gallons of CUD water and 1.5 million gallons of DS water were collected. Flows from the CUD and DS were captured from May 8 to October 30, 2014. The HDS Treatment Plant treated and discharged approximately 3.8 million gallons to Leviathan Creek.

Spring commissioning activities were initiated at the HDS Treatment System on April 18. The HDS Treatment System was commissioned on May 27 and operated through October 30 to treat flows from the CUD and DS, as well as approximately 200,000 gallons of water existing in Pond 4 at the beginning of the treatment season that had collected during the previous winter. The volume of stored water in Pond 4 was reduced to the lowest extent possible using the HDS Treatment System prior to winter shutdown.

Approximately 11.2 tons of non-RCRA California hazardous waste solid (sludge) (36.7% solids) produced from the HDS Treatment Plant was disposed of at US Ecology in Beatty, Nevada. The HDS Treatment Plant was effective at treating impacted CUD and DS water to below the site discharge criteria.

2015 – In 2015, approximately 2.2 million gallons of CUD water and 1.6 million gallons of DS water were collected. Flows from the CUD and DS were captured from May 9 to October 19, 2015. The HDS Treatment Plant treated and discharged approximately 3.6 million gallons to Leviathan Creek.

Spring commissioning activities were initiated at the HDS Treatment System on April 1, 2015. The HDS Treatment System was commissioned on May 9 and operated through October 19, 2015 to treat flows from the CUD and DS, as well as approximately 47,000 gallons of water existing in Pond 4 at the beginning of the treatment season that had collected during the previous winter. The volume of stored water in Pond 4 was reduced to the lowest extent possible using the HDS Treatment System prior to winter shutdown.

Approximately 42.7 tons of non-RCRA California hazardous waste sludge (approximately 25% solids) produced from the HDS Treatment Plant was disposed of at US Ecology in Beatty, Nevada. The HDS Treatment Plant was effective at treating impacted CUD and DS water to below the site discharge criteria.

2.2.2 Aspen Seep

The AS (also referred to as the Overburden Seep) produces influent flows year-round at a rate ranging between approximately 1 and 33 gpm from low points below overburden in the Aspen Creek drainage. Flows at the AS are treated with the ASB Treatment System. The ASB Treatment System initially operated (1996 through 2003) during the summer and early fall months. In 2004, the ASB Treatment System began year-round operations. A generalized description of the ASB Treatment System is provided below as background information, a detailed description of the ASB Treatment System operations is provided in Section 4.3.1.

- **ASB Treatment System** – The ASB Treatment System treats flows from the AS prior to discharge to the aeration channel leading to Aspen Creek. The ASB Treatment System utilizes sulfate-reducing bacteria, supported by ethanol as an organic carbon food source, to produce sulfide for removal of dissolved metals by metal sulfide precipitation. Sodium hydroxide (NaOH) is added for pH adjustment to produce a suitable pH environment for the sulfate-reducing bacteria and to encourage metal sulfide precipitation, which occurs at neutral to slightly alkaline conditions. The ASB Treatment System generally consists of a series of ponds, chemical feed pumps, recirculation pumps, a remote telemetry system, and a power source.

The following is a brief overview of past activities conducted to address discharges at the AS:

1996-2000 – The original ASB Treatment System was designed, constructed, and pilot tested by the LRWQCB in collaboration with the University of Nevada, Reno. The history and performance of the bioreactors through 2000 is presented in detail in the Operation and Monitoring of Bioreactors at the Leviathan Mine Report (Atlantic Richfield, 2001).

2001 – In 2001, efforts at the ASB Treatment System included the installation of solar panels to drive peristaltic pumps that dosed NaOH to the system for pH adjustment to enhance the removal of iron as iron sulfide.

2002-2003 – AS water was treated using the previous year's bioreactor system from January to August of 2002. After August 2002, construction began on the infrastructure of the current bioreactor system, which was designed to be larger, gravity-operated, and have improved flow distribution, flushing, and sludge retention. Construction was completed in the spring of 2003. The newly constructed bioreactor treatment system consisted of a collection trench, five ponds (a pretreatment pond, two biocell ponds, and two settling ponds, denoted ASB Treatment System Pond 3 and Pond 4), and an aeration channel. During this time, evaluation and testing of four alternative alkaline additives to potentially replace NaOH were carried out. The evaluation concluded that NaOH was the most effective option for the application and therefore it was used from this point forward.

2004 – Starting January 1, 2004, the entire AS was captured and the newly constructed ASB Treatment System was operated as designed. A total of approximately 1.7 million gallons were treated and discharged to the aeration channel leading to Aspen Creek between January 1 and May 11. On May 12, the "recirculation" mode of operation was initiated by directing influent AS water into the first settling pond and adding a submersible pump (powered by a diesel generator) in the first settling pond to pump water to the pretreatment pond. The purpose of these changes was to reduce the amount of sludge that was produced and collected in the biocells by encouraging mixing of the metal-laden influent water with the sulfide-rich biocell effluent, and subsequent metal sulfide sludge formation, in the first settling pond rather than in the biocells. The recirculation pump provides water with low metals and high sulfate concentration to the biocells for sulfide production. For the remainder of 2004, the system was operated in the recirculation mode, treating approximately 2.8 million gallons prior to discharge to the aeration channel leading to Aspen Creek.

2005 – The ASB Treatment System was operated for the entire year. Approximately 6.8 million gallons (an approximate 240% increase over the 2004 volume) from the AS was collected and treated using the recirculation mode of operation. Due to a relative increase in annual precipitation (mainly as snow), flows and metal concentrations were elevated, thereby necessitating increased reagent dosing rates compared to previous years. A minimal amount of sludge was removed from ASB Treatment System Pond 3, Biocell 1, and Biocell 2 by pumping via trash pump into filter bags. The filter bags were stored on site through the winter and were removed in 2006.

2006 – The ASB Treatment System collected and treated approximately 7.9 million gallons. During this year, several engineering upgrades were accomplished, including the installation of two flow meters (one for the primary recirculation pipeline and one for the effluent pipeline). From July through early October, a treatability test was conducted to use a biodiesel by-product consisting mainly of glycerol and methanol as a carbon source for the system. The test concluded that ethanol was the most effective option and ethanol use was resumed after the experiment. Larger, more permanent storage tanks were purchased to allow greater on-site storage capacity for sodium hydroxide and ethanol.

Prior to the spring of 2006, the ASB Treatment System had operated since construction (approximately three years) with minimal sludge removal. During spring 2006, the volume of sludge accumulation in ASB Treatment System Pond 3 reached a level requiring removal. Consequently, ASB Treatment System Pond 3 sludge was pumped either into filter bags for dewatering, pumped into ASB Treatment System Pond 4 to await future removal, or pumped into containers or a vacuum truck for off-site disposal. In 2006, non-hazardous waste solids and liquids by RCRA and California regulations were disposed of at US Ecology in Beatty, Nevada during September and October including: approximately 27 cubic yards (cy) collected in filter bags from the 2005 and 2006 seasons; approximately 77.7 cy of non-dewatered sludge from the pretreatment pond; and approximately 228.1 cy of non-hazardous non-dewatered sludge from ASB Treatment System Pond 3.

2007 – During 2007, approximately 4.0 million gallons of water from the AS were treated and discharged. Activities completed at the ASB Treatment System during 2007 included operating and monitoring the bioreactor, sampling influent and discharged water, and performing various modifications, including replacement of the diesel generator with propane generators and completing improvements to optimize the existing system components.

Two methods of sludge removal including the filter bag method and mobile belt filter press method were pilot tested to evaluate the feasibility of sludge dewatering at the ASB Treatment System. As a result of these pilot tests, it was determined that investigation of alternative sludge handling and dewatering methods should continue. Approximately 5.6 tons of non-hazardous sludge dewatered in the filter bags and approximately 59.3 tons of non-hazardous sludge dewatered in the belt filter press were removed from the ASB Treatment System and disposed of in October 2007 at US Ecology in Beatty, Nevada.

2008 – Approximately 3.2 million gallons of water from the AS were treated and discharged in 2008. Activities completed during 2008 at the ASB Treatment System included bioreactor operations and maintenance (O&M)[2], monitoring of system performance, sampling influent and treated water, and performing improvements and upgrades to optimize the existing system components. In June, Atlantic Richfield began additional sample collection and analysis at the ASB Treatment System to aid in the assessment of bioreactor performance. The performance evaluation was carried out to better examine the biogeochemical processes that occur within the bioreactor and the results of the evaluation were presented to the U.S. EPA in October 2008.

A belt filter press (similar to the 2007 mobile belt filter press pilot test) was mobilized to the site in July 2008 to dewater sludge from the ASB Treatment System. The 2008 sludge removal activities included: multiple events of biocell flushing and biocell pipe flushing, sludge removal from the ASB Treatment System Pond 3 and Pond 4 and the installation of a permanent conveyance line to the belt filter press operations. Approximately 57.7 tons of non-hazardous sludge were removed from the ASB Treatment System and disposed of in September 2008 at US Ecology in Beatty, Nevada.

2009 – During 2009, approximately 3.2 million gallons of water from the AS were treated and discharged. Activities completed during 2009 at the ASB Treatment System included bioreactor O&M, monitoring of system performance, sampling influent and treated water, replacing the ethanol and NaOH bulk chemical storage tanks, and performing improvements and upgrades to optimize the existing system components. In July, Atlantic Richfield began additional sample

[2] As used throughout this report, the term "operations and maintenance" or "O&M" is meant to refer to the ongoing operation and maintenance of removal action equipment and treatment system components implemented in accordance with the requirements of the AOC. Use of this term is not meant to imply that response actions at the site have reached a point where "operation and maintenance (O&M) measures" need to be initiated under 40 CFR § 300.435(f).

collection and analysis at the ASB Treatment System to aid in the assessment of bioreactor performance. The performance evaluation was carried out to examine the biogeochemical processes that occur within the bioreactor and the results of the evaluation were presented to the U.S. EPA in December 2009.

Two sludge dewatering and removal efforts were tested in 2009: a mobile centrifuge, and a sludge drying bed (SDB) pilot test. Prior to the centrifuge dewatering effort, a separate conveyance line was added to allow for simultaneous pumping of sludge from the ASB Treatment System to the centrifuge, and discharge of filtrate water from the centrifuge to the ASB Treatment System Pond 4. Additionally, flushing of sludge from the biocells into ASB Treatment System Pond 3 was completed before pumping of sludge to the centrifuge commenced. Approximately 42 tons of non-hazardous sludge were removed from the ASB Treatment System and disposed of at US Ecology in Beatty, Nevada. The SDB pilot test consisted of two filter bins; one was configured for testing dewatering by evaporation and the other was configured for testing dewatering by filtration, decanting and evaporation. The SDB pilot test was completed in 2010.

2010 – During 2010, approximately 3.7 million gallons of water from the AS were treated and discharged. Activities completed during 2010 at the ASB Treatment System included bioreactor O&M, monitoring of system performance, sampling influent and treated water, and performing improvements and upgrades to optimize the existing system components. Upgrades completed during 2010 include the installation of a year-round safety shower, installation of new chemical pumps and tank monitoring sensors, installation of a new Programmable Logic Controller (PLC), extension of the existing sludge conveyance pipeline, installation of backup recirculation and influent pipelines, and aeration channel access improvements. Similar to 2009 activities, in June 2010, Atlantic Richfield began additional sample collection and analysis at the ASB Treatment System to continue the assessment and optimization of bioreactor performance. The performance evaluation results were presented to the U.S. EPA in February 2011 in a teleconference.

A mobile centrifuge was used to dewater sludge in 2010. Approximately 95 tons of non-hazardous sludge was removed from the ASB Treatment System and disposed of at US Ecology in Beatty, Nevada.

2011 – During 2011, approximately 7.2 million gallons of water from the AS were treated and discharged. Activities completed during 2011 at the ASB Treatment System included bioreactor O&M, monitoring of system performance, sampling influent and treated water, and performing improvements and upgrades to optimize the existing system components. Upgrades completed during 2011 included nutrient addition adjustments, sodium hydroxide tubing modifications, power generation system improvements and satellite accumulation area improvements. Similar to 2010 activities, in June 2011, Atlantic Richfield began additional sample collection and analysis at the ASB Treatment System to continue the assessment and optimization of bioreactor performance. The performance evaluation results were presented to the U.S. EPA in February 2012 in a teleconference.

A mobile centrifuge was used to dewater sludge in 2011. Approximately 86 wet tons (15 dry tons) of non-hazardous sludge was removed from the ASB Treatment System and disposed of at US Ecology in Beatty, Nevada.

2012 – During 2012, approximately 3.7 million gallons of water from the AS were treated and discharged. Activities completed during 2012 at the ASB Treatment System included bioreactor O&M, monitoring of system performance, sampling influent and treated water, and performing improvements and upgrades to optimize the existing system components. Upgrades completed during 2012 included pipeline repair and insulation, generator exhaust stack extension, and generator emergency stop installation. Similar to 2011 activities, in June 2012, Atlantic Richfield began additional sample collection and analysis at the ASB Treatment System to continue the assessment and optimization of bioreactor performance. The performance evaluation results were presented to the U.S. EPA in February 2013 in a teleconference.

A number of dewatering technologies were utilized and evaluated in 2012, and approximately 163 wet tons (13 dry tons) of non-hazardous sludge were removed from the ASB Treatment System and disposed of at US Ecology in Beatty, Nevada.

2013 – During 2013, approximately 2.3 million gallons of water from the AS were treated and discharged. Activities completed during 2013 at the ASB Treatment System included bioreactor O&M, monitoring of system performance, sampling influent and treated water, and performing improvements and upgrades to optimize the existing system components. Upgrades completed during 2013 included telemetry system modifications, propane generator engine replacement, and test/bypass line abandonment preparation.

Due to low flows, and therefore decreased sludge generation, sludge was not removed from the ASB Treatment System in 2013.

2014 – During 2014, approximately 1.2 million gallons of water from the AS were treated and discharged. Activities completed during 2014 at the ASB Treatment System included bioreactor O&M, monitoring of system performance, sampling influent and treated water, and performing improvements and upgrades to optimize the existing system components. Upgrades completed during 2014 included fire alarm relay separation , Human Machine Interface (HMI) replacement, recirculation pump wiring and platform railing upgrades, power reliability upgrades, fire control panel replacement, and by-pass line abandonment.

Due to low flows from late 2013 through 2014, and therefore decreased sludge generation, sludge was not removed from the ASB Treatment System in 2014.

2015 – During 2015, approximately 790,000 gallons of water from the AS were treated and discharged. Activities completed during 2015 at the ASB Treatment System included bioreactor O&M, monitoring of system performance, sampling influent and treated water, and performing improvements and upgrades to optimize the existing system components. Upgrades completed during 2015 included Pond 3 stair replacement, and power reliability upgrades which included replacing power system inverters and generator contactors.

Approximately 33.3 wet tons (3.3 dry tons) of non-hazardous sludge were removed from the ASB Treatment System and disposed of at US Ecology in Beatty, Nevada.

3.0 HEALTH AND SAFETY PERFORMANCE AND COMMUNITY RELATIONS

The following sections discuss the 2016 health and safety performance and community relations for the site.

3.1 2016 Health and Safety Performance

During 2016 operations, morning safety meetings were conducted daily with all on-site workers and visitors so that each person was aware of the day-to-day HSSE concerns such as current site conditions, weather forecasts, deliveries, and the daily scope of work. Learning opportunities from the previous day's work were also discussed during the morning safety meetings.

An orientation to the site was provided to every Atlantic Richfield-related person who conducted work or visited the site in 2016. The Health and Safety Coordinator presented the orientation, which provided information on specific procedures including the permit system and a briefing on work practices and policies, expectations, codes, and standards set forth in the HSSE Program Document.

In accordance with the HSSE Program Document, incidents, near misses, and Stop Work scenarios at the site were reported to the Health and Safety Coordinator. Of the approximate 43,518 hours worked on- and off- the site during 2016 (including subcontractor hours), there were zero first-aid cases and zero Occupational Safety and Health Administration (OSHA) recordable injuries. Site personnel identified two near miss es and 39 Stop Work scenarios, none of which involved injuries. These were considered health and safety learning opportunities and discussed during the daily safety meeting on the mornings after they occurred. In addition, the standard practices and procedures for the site were modified as appropriate to reflect these learning opportunities.

3.2 2016 Community Relations

Community relations activities conducted in 2016 and early 2017 included the following:

Leviathan Mine Road Notice of Road Wor k – On May 24 , 2016, a Notice of Road Work was distributed to the residents along Leviathan Mine Road to notify them of scheduled road maintenance and dust suppression activities.

Technical Summary Meeting – On January 26, 2016, a meeting was conducted with the agencies and stakeholders to inform them of the progress being made on the Removal Action and RI/FS activities. During this meeting, which the U.S. EPA hosted, Atlantic Richfield, LRWQCB, David Herbst, and the U.S. EPA made presentations to describe the work completed, and the U.S. EPA was available to respond to questions from the public and stakeholders regarding the work being conducted.

Stakeholder Review and Comments on Site Documents – The U.S. EPA is the lead agency for compiling comments from the stakeholders on site-related documents. The U.S. EPA provided certain documents submitted by Atlantic Richfield in 2016 to the stakeholders for comment.

Project Information Repositories – Certain project documents and other site communications are posted to a Web site, as well as two separate repositories as they become available. The stakeholders and the public have access to the Web site and repositories for review of this information.

Public Information Sites – Both the U.S. EPA and the LRWQCB post project reports and other information to each agency's Web pages for the site. The U.S. EPA maintains the Superfund Site Web page and the LRWQCB maintains a Web site where the proceedings of the Regional Board are posted.

4.0 2016 REMOVAL ACTION ACTIVITIES

The following sections summarize the Removal Action activities implemented by Atlantic Richfield during 2016, including operation of the HDS and ASB Treatment Systems. All activities were completed in accordance with the RAWP including amendments (Atlantic Richfield, 2013a), and the treatment objectives listed below in Section 4.1.

4.1 Objectives

The overall site objectives for activities conducted under the AOC and as cited in the RAWP were as follows:

1. Collect information that will be used to identify effective, reliable, and suitable treatment methods that may be incorporated into the long-term remedy for the site; and
2. Treat the previously identified flows (CUD, DS, and AS) to discharge criteria previously established for the site to the extent practicable for a removal action.

Removal action activities, including evaluation and system improvements are described in the remainder of Section 4.0. Monitoring activities and monitoring results are presented in Section 5.0 and Section 6.0, respectively.

4.2 CUD and DS Treatment Related Activities

In 2016, various treatment-related activities were conducted to treat flows from the CUD and DS. Section 4.2.1 describes activities associated with site access, LAS mobilization, and general activities in the Pond 4 area necessary to support work at the site. Section 4.2.2 describes the HDS Treatment System and routine system O&M activities, and Section 4.2.3 describes HDS Treatment System evaluations and improvements implemented in 2016.

4.2.1 Site Access, LAS Mobilization, and General Site Setup Activities

The U.S. EPA was notified of the commencement of mobilization activities on March 30, 2016. Road maintenance on the Nevada access route of Leviathan Mine Road starting approximately ½ miles from US 395 (Figure 1) and proceeding into the site w as not required to allow access to the site in 2016. Snow removal was not required in 2016. Site setup activities in the Pond 4 area began on April 5, 2016, which included HDS Treatment System generator commissioning, delivery of office trailers, satellite communications equipment setup, and delivery of tools and general supplies to support treatment activities. Site setup was periodically delayed due t o inclement weather and HSSE concerns. HDS Treatment Systems activities began shortly thereafter, and are described in the following sections.

4.2.2 HDS Treatment System

The HDS Treatment System is comprised of the CUD and DS collection and conveyance equipment, Pond 4, the HDS Treatment Plant (including the process equipment), and the HDS Power Generation System. A layout of the HDS Treatment System, including sampling locations, is presented in Figure 3. The layout of the HDS Treatment Plant equipment, including the HDS Power Generation System equipment is presented in Figure 4. The HDS Treatment System process flow diagram is presented in Figure 5.

The HDS Treatment System is designed to treat combined flows from the CUD and DS up to 100 gpm. Flows from the CUD and DS are captured and pumped to Pond 4 for temporary storage. Untreated water (influent) is pumped from Pond 4 to the HDS Treatment Plant where it is reacted with hydrated lime to increase the pH and precipitate dissolved metals, and dosed with flocculant to enhance solids removal from the reacted water. The process generated solids settle in the clarifier as sludge. Clarified water (effluent) flows from the clarifier to the effluent tank and may be discharged directly to Leviathan Creek or recycled back to Pond 4. A portion of the sludge in the bottom of the clarifier is recycled throughout the process to increase the density of the sludge and decrease water content. Sludge is wasted (or removed) periodically by pumping sludge from the bottom of the clarifier to sludge dewatering bins.

Routine HDS Treatment System O&M activities conducted in 2016 are divided into the following categories:

- Spring commissioning and startup;
- Operations and consumable usage;
- Maintenance activities;
- Sludge management; and
- Winter shutdown and storage.

These activities are discussed in further details in the following sections.

4.2.2.1. Spring Commissioning and Startup

The HDS Treatment System is commissioned every year following winter shutdown. Spring commissioning of the HDS Treatment System began on April 5, 2016 and was completed on May 4, 2016. Following site access activities, consumables left on-site over the winter to facilitate early start-up, including diesel, flocculant, and hydrated lime, were inspected and determined to be suitable for use. The HDS Power Generation System was commissioned to restore power to the site on April 5, 2016. On May 10, 2016, the HDS Treatment System operations began treating accumulated water in Pond 4 and discharging compliant water to Leviathan Creek.

Commissioning of the CUD and DS collection and conveyance equipment and initiation of capture of CUD and DS flows were completed on May 16, 2016, and included the following activities:

- Health and safety equipment, including the portable eyewash stations, first aid kits, and fire extinguishers, were reinstalled;
- Electrical equipment installed on the conveyance lines, including level controls, motor control valves, flow meters, and electrical panels, were tested and the desiccant/moisture absorbent and shrink-wrap were removed;
- The heat trace was tested and returned to service;
- The piping connecting the CUD weir[3] to the CUD Collection Tank was inspected, cleaned, and re-connected;
- The CUD and DS conveyance lines were pressure tested;
- The conveyance pumps were reinstalled and tested; and
- The conveyance tank stainless steel piping modifications and conveyance pump intelligent variable frequency drive (iVFD) upgrades were completed (Section 4.2.3).

Prior to initiating the conveyance system, the Pond 4 water level was approximately 5.8 feet (relative to the United States Geological Survey (USGS) staff gauge height). At least five days of holding capacity in Pond 4 was maintained in the event of unanticipated start-up delays.

Commissioning of the HDS Treatment Plant commenced and included the following activities:

- The HDS Treatment Plant piping was reconnected and visually checked for leaks;
- All electrical terminations were inspected and torqued;
- Equipment, including blowers, pumps, screw conveyors, vibrators, and agitators were serviced in accordance with the manufacturer's recommendations and were returned to service;
- The lime and flocculant systems were serviced, tested, commissioned, and returned to service;
- HSSE infrastructure, i.e. Safety Shower, eye wash, fresh water system, etc. was installed/commissioned and tested;

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[3] Flow and stage monitoring equipment (weirs, gauge houses, bubblers, data recorders, staff gauge, etc.) at the CUD, AS, and Pond 4 are the property of the LRWQCB. These facilities were formerly operated by the United States Geological Survey (USGS) for the LRWQCB. As of December 11, 2012, under verbal agreement with the LRWQCB, Atlantic Richfield assumed responsibility for maintenance of the flow monitoring equipment and downloading of flow data from the data loggers at these stations.

- Sensitive electrical equipment, including pH probes and the turbidity probe which had been stored off-site during winter shutdown were reinstalled and calibrated; and
- The HMI and data historian computers were reinstalled in the Operator Trailer.

On May 10, 2016, the HDS Treatment Plant began treating water from Pond 4. The HDS Treatment Plant was initially started in the Recycle Mode, discharging effluent back to Pond 4 with no water discharging to Leviathan Creek. Once the HDS Treatment Plant water quality parameters stabilized, an effluent sample was collected and the HDS Treatment Plant effluent surrogate field parameters (field measured pH and dissolved iron concentrations, as described in Section 5.2.1) were confirmed to meet discharge criteria. The HDS Treatment Plant was subsequently placed in the Normal Mode of operation and began discharging to the channelized portion of Leviathan Creek at approximately 80 gpm on May 10, 2016. The influent flow rate into the HDS Treatment Plant was reduced to 40 gpm on May 12, 2016 and treatment of accumulated water in Pond 4 was halted on May 13, 2016 in preparation for the startup of the conveyance system and routine HDS Treatment Plant operations on May 16, 2016.

4.2.2.2. Operations and Consumable Usage

The HDS Treatment System is designed to operate 24 hours a day during the ARWS and portions of the LAS. System operators were on-site during daily shifts (weather and access permitting) to maintain system operations and perform routine system checks.

Similar to previous years and in accordance with the RAWP, the suitability of water quality for discharge from the HDS Treatment Plant was assessed by surrogate field parameter monitoring. Additionally, the HDS Treatment Plant utilizes continuous pH and turbidity monitoring for operational control, which indicates if effluent quality has changed significantly between surrogate field monitoring events. Based on operational data from previous years, the HDS Treatment Plant was operated to achieve an effluent pH operating range of 7.5 to 8.9 standard units (s.u.). Operators also collected confirmation compliance samples for laboratory analysis in accordance with the sampling and analysis procedures specified in the RAWP and summarized in Section 5.2.

The HDS Treatment Plant operated continuously throughout 2016 except during interruptions to the system described in Table 14 . The capture of CUD and DS flows continued during intermittent shutdowns . During operations, the HDS Treatment Plant discharged directly to Leviathan Creek, except during planned shutdowns, which are discussed in Section 6.1.3 and Table 14.

In order to treat flows from the CUD and DS, the HDS Treatment System requires various consumables, including: diesel to operate the generators as part of the power generation system, flocculant to enhance solids removal from the reacted water, hydrated lime to raise the influent pH and precipitate dissolved metals, and freshwater for various plant wash down activities and commissioning flocculant system. The quantities consumed and utilization rates for these chemicals are presented in Section 6.1.4.

4.2.2.3. Maintenance Activities

Periodic HDS Treatment System equipment maintenance requirements were scheduled and performed by site personnel, specialized maintenance contractors, and/or off-site maintenance specialists, as appropriate. Typical maintenance activities for the HDS Treatment System included the following:

- Maintaining a preferential flow pathway through the 6-inch minus rip-rap from the DS to the fanned culvert inlet by moving and cleaning the riprap;
- Periodically cleaning or replacing, as necessary, the CUD and DS conveyance lines, level controls, and valves;
- Inspecting the conveyance equipment for wear and repairing or replacing them as required; and
- Periodically inspecting, cleaning, lubricating, calibrating, adjusting, or replacing HDS Treatment Plant and HDS Power Generation System equipment as necessary.

Non-routine maintenance activities or equipment failures resulting in short-term HDS Treatment Plant interruptions are detailed in Section 6.1.3 and Table 14.

4.2.2.4. Sludge Management

The HDS Treatment System process produces sludge comprised primarily of water, reacted lime, and metal precipitates. Accumulated sludge in the clarifier was wasted (removed from the clarifier) periodically to the sludge dewatering bins. A total of 25,460 gallons of sludge were wasted from the clarifier to the dewatering bins in 2016 . The dewatering bins were staged to the east of the process building on a concrete pad and were lined with a nonwoven filter fabric for sludge dewatering. The filtered liquid (supernatant) that drained from the dewatering bins into the Sludge Bin Sump was pumped either back to the HDS Treatment Plant or to Pond 4 for subsequent treatment. When a dewatering bin was ready for removal, the sludge was profiled and transported under manifest by Ponder Environmental Services, Inc. to US Ecology in Beatty, Nevada, for disposal. HDS Treatment Plant sludge generated in 2016 was profiled as a non-RCRA California hazardous waste. A total of six sludge dewatering bins were filled, and 50.46 tons of dewatered sludge were disposed off-site during 2016.

4.2.2.5. Winter Shutdown and Storage

To protect the equipment from damage and in consideration for worker safety due to inclement weather and freezing temperatures experienced during the LAS, the CUD and DS collection and conveyance equipment was shut down on October 12, 2016. The HDS Treatment Plant ceased discharge to Leviathan Creek on October 12, 2016 with approximately eight inches of water remaining in Pond 4.

Winterization activities then commenced for the HDS Treatment System and Pond 4 work area, and included the following:

- The conveyance pumps in the CUD, DS, and DST collection tanks were removed, cleaned, inspected, and stored off-site;
- The conveyance lines were drained and blown free of water using an air compressor to minimize potential damage due to freezing conditions;
- The piping connecting the CUD weir to the CUD collection tank was disconnected, diverting the flow from the weir to Leviathan Creek;
- The drain from the DS Collection Tank was opened to allow DS flow to pass through the tank and into Leviathan Creek;
- The DS Mid-tank was emptied and cleaned;
- Electrical equipment installed on the conveyance lines, including level controls, motor control valves, flow meters, and electrical panels, were winterized and shrink-wrapped with desiccant/moisture absorbent containers;
- The lime system was emptied and cleaned. Approximately 0.16 tons of excess/residual lime in the system was mixed with process water and discharged to Pond 4. Operators minimized the amount of lime transferred to Pond 4 during this cleaning process by anticipating the lime usage required prior to shut down and limiting the amount of lime placed into the storage hopper;
- Equipment including blowers, pumps, and agitators were winterized, and the motors were shrink-wrapped with desiccant/moisture absorbent containers;
- Sludge from the clarifier was pumped into the sludge dewatering bins to minimize the amount of sludge transferred to Pond 4;
- The HDS Treatment Plant piping was flushed with freshwater, drained of remaining water, and blown-out with air to reduce the potential for freeze damage;
- Sensitive HDS Treatment Plant equipment, such as pH probes and the turbidity probe, were removed and stored off-site;
- HDS Treatment Plant tanks and sumps were drained and cleaned;
- The 5,000-gallon diesel above ground storage tank (AST) was filled to a volume of 3,833 gallons and a winter fuel conditioner was added to mitigate condensation and facilitate early commencement of spring commissioning activities in 2017;
- Unused hydrated lime bags were wrapped for moisture protection and stored inside the HDS Treatment Plant for the winter;
- The temporary field office trailers were removed; and
- The power generation system was shutdown, the generators were winterized, and the batteries were removed for winter storage.

Upon completion of all winterization activities on November 1, 2016, the HDS Treatment Building, HDS Power Generation Building, and Pond 4 access gates were locked and secured as personnel departed from the site for the winter.

4.2.3 HDS Treatment System Evaluations and Improvements

In 2016, HDS Treatment System engineering evaluations and improvements were conducted to ensure and promote safe, reliable and efficient operations. HDS Treatment System engineering and evaluations were presented in the 2016 Annual Amendment to the RAWP (Atlantic Richfield, 2016a). During the 2016 LAS and ARWS, Atlantic Richfield completed the following improvements:

- Replaced conveyance pump discharge hoses with stainless steel pipi ng at CUD, DS, and DST collection tanks;
- Replaced variable frequency drives (VFDs) with iVFDs at CUD, DS, and DST conveyance stations;
- Installed instrumentation and alarm for high temperature local control panel (LCP) at CUD, DS, and DST conveyance stations; and
- Tested the polarity of the lime screw feeder in preparation for ICT demonstration.

These improvements are described in detail in the following sections.

4.2.3.1. Conveyance Station Stainless Steel Piping Upgrades

The conveyance pump discharge flexible hoses were replaced with two-inch 316L stainless steel pipes to prevent future hose failures as a result of the flexible hose splitting or cracking . The stainless steel pipe was connected to the existing polyvinyl chloride (PVC) conveyance pipe outside of the tanks. Unistrut piping support was installed to prevent stress on the pump discharge flange when pulling the pump and pipe from the tank. Additional pipe supports were installed on the outside of the tank to provide a secure footing for the new 316L stainless steel pipe. The rigidity of the discharge pipe and pipe support secure the pump in place and prevent the pump from tipping over. In addition, motor operated control valves were replaced with stainless steel check valves. The capture and conveyance system stainless steel piping upgrades were completed in May 2016 in accordance with a Management of Change (MoC) that was approved by Atlantic Richfield.

4.2.3.2. Capture and Conveyance System VFD Replacement

To maintain reliability of the CUD and DS capture and conveyance system, VFDs for the pumps installed in CUD, DS, and DST tanks were replaced with iVFDs equipped with an integrated PLC . Replacing the VFDs with iVFDs allow the conveyance pumping stations to operate independently of the Main PLC at the HDS Treatment Plant. The main PLC still provides the set-point for the level control but level indication from the conveyance tanks is an input to the logic processor integrated with the i VFD. The logic processor within the iVFD starts or stops the pumps based on the level input. This modification minimizes the potential for conveyance system failures and the potential release of untreated water to Leviathan Creek due to tank overflow. The capture and conveyance system VFDs were replaced in May 20 16 in accordance with a MoC that was approved by Atlantic Richfield.

4.2.3.3. Instrumentation and Alarm for High Temperature LCP

The CUD, DS, and DST LCPs have small air conditioning units to prevent the control panels from overheating during the summer. Failure of the air conditioning units could cause critical electrical components to fail due to high temperature. Temperature instruments and associated alarms were installed and tested in May of 2016 to alert operators if the air conditioning units failed so they can take action that will reduce the potential for components to fail.

4.2.3.4. Lime Feed Increased Capacity

During the ICT demonstration using the HDS Treatment Plant anticipated in 2017, additional feed capacity of the lime addition system will be necessary. A test was performed to increase the capacity of the lime feed conveyor by increasing the rotational speed. The test indicated that the lime delivery rate can increase from 2.5 pounds (lbs) per minute to approximately 7 lbs per minute. The maximum lime feed rate required for the ICT demonstration is 2.7 lbs per minute, therefore, no additional modifications to the lime feed system are required to perform the ICT test.

4.3 Aspen Seep Treatment Related Activities

In 2016, various treatment-related activities were conducted to treat flows from the AS. Section 4.3.1 describes the ASB Treatment System and the routine O&M activities, and Section 4.3.2 describes ASB Treatment System evaluations and improvements implemented in 2016.

4.3.1 ASB Treatment System Operations

A layout of the ASB Treatment System, including sampling locations, is presented in Figure 6. The ASB Treatment System process flow diagram is presented in Figure 7. The ASB Treatment System generally consists of a collection area, followed by a series of five ponds, one of which was initially designed as a pre-treatment pond, two of which are filled with a rock matrix (denoted as Biocells 1 and 2) to provide surface area for the growth of attached sulfate-reducing bacteria (SRB), and two of which are the initial and final settling ponds (denoted as ASB Treatment System Ponds 3 and 4, respectively). Influent AD to the ASB Treatment System flows from the seep collection area through the Aspen influent weir for flow measurement prior to treatment. Atlantic Richfield began measuring flow using the Aspen influent weir in December 2012 as described in Section 5.2.3.1. The pH of the influent water is adjusted with NaOH and mixed with sulfide-rich biocell effluent prior to entering ASB Treatment System Pond 3. From ASB Treatment System Pond 3, a portion of the water is pumped to the pre-treatment pond at the head of the biocells. Flow from the pre-treatment pond provides influent water to the biocells. Water flows through biocell 1 and 2 prior to discharge back to ASB Treatment System Pond 3, creating a recirculation loop. This recirculation flow configuration has been used exclusively during normal operations since 2004, to promote solids settling within ASB Treatment System Pond 3 instead of in the biocells, improving water conditions for the SRB and reducing sludge accumulation in the biocells.

The ASB Treatment System requires two chemical feeds: an ethanol blend as an organic carbon food source for the SRB, and NaOH to increase the pH. Increasing system pH promotes formation and precipitation of metal sulfides, and creates more favorable conditions for the SRB. The ethanol and NaOH are dosed into the ASB Treatment System by peristaltic pumps. Additionally, urea and trisodium phosphate (TSP) are manually added to the biocells to provide the macro-nutrients nitrogen and phosphorus to promote SRB growth.

A propane fired generator based battery-integrated power supply system was installed and modified in 2007 and 2008, respectively. The generators are used to charge the batteries from which inverted power is used to operate the various system components. The integrated battery bank powers all system equipment and allows the propane generators to cycle operation, thus reducing generator run-time and fuel consumption, extending the interval required for generator maintenance, and facilitating less frequent O&M site visits during the LAS.

The ASB Treatment System is monitored and controlled (both locally and remotely) by a supervisory control and data acquisition (SCADA/WIN-911) system. The primary components of the SCADA/WIN-911 system are the HMI and the PLC, which facilitate control and monitoring of the chemical feed and recirculation pumps, flow meters, generators, and battery bank. A network camera facilitates remote inspections of site conditions, such as current snow levels and ASB Treatment System process water color as it enters ASB Treatment System Pond 3. The power inverters are equipped with a Sunny WebBox, which facilitates remote power quality data access and inverter control. Off-site access to the network camera, Sunny WebBox, and SCADA/WIN-911 system is available through web based applications via satellite internet communication. The SCADA/WIN-911 system, network camera and Sunny WebBox improve overall reliability of the ASB Treatment System by enabling remote inspections of site conditions and providing limited troubleshooting capabilities.

Routine ASB Treatment System O&M activities conducted in 2016 are separated into the following categories:

- Operations and consumable usage;
- Maintenance activities;
- Sludge management; and
- Winter access.

These activities are discussed in further detail in the following sections.

4.3.1.1. Operations and Consumables Usage

During 2016, Atlantic Richfield operated the ASB Treatment System to continuously treat flows from the AS. During the LAS, the ASB Treatment System was visited approximately once monthly as required for operations. Remote inspections via the SCADA/WIN-911 system, Sunny WebBox, and AXIS network camera were performed to monitor on-site operations between site visits during the LAS. During the ARWS, the ASB was visited approximately daily to maintain system operations.

During ASB Treatment System operations, operating parameters, including ethanol and NaOH dosing rates, and recirculation flow rates, were verified and adjusted as necessary. NaOH dose rates were adjusted as described in the ASB Treatment System O&M Manual (Atlantic Richfield, 2016h) to achieve an effluent pH between 7.2 and 9.0 s.u. Based on historic operations, this pH operating range consistently results in effluent with dissolved metals concentrations below discharge criteria.

The ASB Treatment System operated continuously in the recirculation flow configuration except during brief interruptions, which are discussed in Section 6.2.3 and Table 15. None of the operational interruptions resulted in discharge of untreated water to the aeration channel leading to Aspen Creek.

During the 2016 ARWS, Atlantic Richfield used various consumables to treat flows from the AS. Ethanol was added as the organic carbon substrate for SRB to promote the bacterial conversion of sulfate to sulfide. NaOH was added to adjust the pH of the influent, promote precipitation of metal sulfides, and create an appropriate environment for the SRB. TSP and urea were added as nutrients for the SRB. Propane was utilized as fuel for the power generation system and heater for the emergency shower. Chemical deliveries were coordinated on an as-needed basis during the ARWS, and to ensure sufficient inventory prior to the LAS. During 2016, three propane deliveries, one NaOH delivery, and one ethanol delivery were completed. TSP and urea were obtained and transported to the site by system operators as needed. The quantities consumed and utilization rates for these chemicals are presented in Section 6.2.4.

4.3.1.2. Maintenance Activities

Equipment maintenance activities were scheduled and performed by site personnel, specialized maintenance contractors, and off-site maintenance specialists, as appropriate. Routine maintenance requirements are detailed in the ASB Treatment System O&M Manual (Atlantic Richfield, 2016h) and include:

- Periodic inspection, replacement, and/or cleaning of influent and recirculation pipelines to mitigate accumulation of scale and flow restrictions;
- Maintenance of the AS collection area geo-textile cover to maintain proper flow through the rock matrix and prevent surface ponding;

- Biocell flushing to maintain proper flow through the rock matrix and prevent surface ponding;
- Periodic cleaning of the NaOH Tertiary Containment area to allow sufficient volume of containment; and
- Periodic inspection, testing, cleaning, fluid replacement, and/or lubrication of ASB Treatment System, power generation system, protective system devices (i.e. smoke detectors, tank level alarms, etc.), and SCADA/WIN-911/Telemetry and Communications System components to ensure optimal equipment operation.

4.3.1.3. Sludge Management

The ASB Treatment System produces biomass from the SRB and precipitates metal hydroxides and insoluble metal sulfides from the influent AD to form sludge. By design, the majority of the sludge is precipitated in ASB Treatment System Pond 3 where the metal-rich influent is mixed with the sulfide-rich effluent from the biocells and sodium hydroxide; however, sludge is also deposited within the biocells, manholes, pipes and other ponds. Annual management or removal of sludge from the ASB Treatment System is necessary to maintain optimal flow through the biocells, prevent pipe clogging, maintain residence time in the biocells and ponds, and promote reliable system performance. Sludge management activities implemented in 2016 included biocell flushing, sludge removal, sludge dewatering, and sludge disposal. Sludge management activities are described below with the exception of sludge disposal, which is described in Section 4.3 .2. Sludge monitoring and sampling activities and characterization results are described in Sections 5.2.1.2 and 6.2.5, respectively.

Biocell Flushing

Flushing of the biocells is necessary to reduce accumulated sludge and preferential flow through the biocells. A flushing event involves draining (or flushing) sludge and water from a biocell by opening three of six available flush loops located at the bottom of the biocell. After a biocell is partially drained, it is refilled with clarified water from ASB Treatment System Pond 3 or 4 based on turbidity of water after flushing and Pond 3 solids level. To ensure flushing of the entire biocell matrix, the flushing process is repeated via the remaining three flush loops. Biocells 1 and 2 were flushed during June 2016 and Biocell 2 was flushed again in July 2016. Sludge removed from the biocells during flushing activities was routed to ASB Treatment System Pond 4 for temporary storage.

Sludge Removal

Sludge removal and dewatering activities were required in 2016 due to the volume of accumulated sludge in the ASB Treatment System Pond 4 and to replace the Pond 4 stairs. During August 2016, in preparation for solids management, the water levels in ASB Treatment System Ponds 3 and 4 were lowered. Once water level in Pond 3 was lowered, planks were installed to ensure overflow from Pond 3 could not enter Pond 4 during solids management to minimize system downtime.

Sludge Dewatering Preparation

Mobilization of sludge removal and dewatering equipment including one mix tank, one filtrate tank, one utility water tank, one portable generator, a high-head diesel pump, a polymer injection system, a utility water pump, a solids feed pump, two dewatering bins, and associated secondary containments began on August 15, 2016. Adler Tank Rentals, Baker Corp., and WaterSolve, LLC. provided the above-mentioned equipment for sludge dewatering activities. Dewatering bins were provided by Ponder Environmental Services, Inc. Equipment and associated piping and manifolds were staged inside spill guards at the sludge dewatering area. To ensure that equipment was operable and free of leaks, the conveyance, storage, and dewatering systems were inspected and tested on-site prior to sludge operations.

Following equipment testing, ASB Treatment System sludge was pumped to the mix tank through a 4-inch diameter high-density polyethylene (HDPE) sludge conveyance pipeline. The layout of the dewatering equipment and associated tanks and sludge/filtrate water conveyance lines is shown on Figure 8.

Sludge Dewatering

Sludge dewatering using 100-µm filter fabric placed within sludge dewatering bins was started on August 23, 2016. During the dewatering operation, sludge was consolidated in Pond 4 and then transferred from Pond 4 to the mix tank, continuously mixed to maintain an appropriate consistency, dosed with polymer, and pumped directly to the filter fabric lined dewatering bins. Sludge was pumped from Pond 4 to the mix tank through the sludge conveyance pipeline every one to three days, depending on operations. Sludge pumping was conducted using a high-head diesel pump equipped with two 4-inch intake hoses with stingers. Operators achieved an appropriate sludge consistency by mixing process water with sludge or by moving the pump intake stingers to locations with lower or higher sludge density. A sludge mix tank was utilized to allow controlled delivery of sludge to the dewatering bins which could not be achieved if sludge was pumped directly from Pond 4.

A total of two dewatering bins were utilized during sludge dewatering operations. Approximately 12,742 gallons of sludge was dewatered. Sludge was pumped into the dewatering bins until it reached its maximum allowable height, then the sludge was allowed to dewater via gravity draining and evaporation until the next pumping cycle or bin removal for disposal. The pumping cycle was repeated three to five times for a single dewatering bin to complete a fill cycle. When sludge was sufficiently dewatered, the dewatering bins were transported off-site for disposal. Sludge disposal is discussed in Section 4.4.2.

During periods of active dewatering when sludge was being pumped to the dewatering bins, the dewatering bin filtrate was allowed to collect in the filtrate tank and discharged back to the ponds through the 4-inch diameter HDPE sludge conveyance line. Prior to discharging filtrate, water quality monitoring was completed as described in Section 5.2.1.2, and evaluated as described in Section 6.2.5.

Following completion of sludge dewatering activities, the mix tank and associated plumbing were cleaned by Broadbent and Associates, Inc. with non-chlorinated water from Gardnerville, Nevada. The rinsate generated during cleaning was directed to the dewatering bins and the bin filtrate was discharged to ASB Treatment System Pond 4. On-site cleaning of equipment began on September 8, 2016 and concluded October 3, 2016 . Additional off-site cleaning of the mix tank was completed by Ponder Environmental Services, Inc. and the generated rinsate was disposed of at U.S. Ecology in Beatty, Nevada.

During 2016, sludge was removed from the system to the fullest possible extent, and the sludge volumes in ASB Treatment System Ponds 3 and 4 were reduced to less than ten percent of total pond operational capacities.

4.3.1.4. Winter Access

Access to the ASB Treatment System during the LAS is necessary to meet the requirements of the AOC. The AOC requires year-round operation and monthly compliance sampling (per approved work plan) of the ASB Treatment System. In addition, winter access is required to perform monthly O&M tasks and troubleshooting, as necessary. Due to the inherent dangers of remote access through snow covered ground and performing work in cold climates, all winter operations site personnel are required to perform annual winter access training prior to access to the site.

Five LAS site visits were made in 2016. A LAS site visit was not performed during the month of February 2016 due to safety concerns with site access. Several attempts were made to access the site (February 9, 16, and 22, 2016) using both four-wheel drive vehicles and snowmobiles using the Nevada access road. However, safe site access could not be achieved due to the road conditions. This did not affect the functioning of the ASB Treatment System. On February 24, 2016, Atlantic Richfield provided an email to U.S. EPA stating the monthly compliance sampling and routine O&M activities could not be completed . Site access during the LAS site visits was accomplished via both snowmobile and four-wheel drive vehicles during the March LAS site visit. Routine access to the site began during the month of April.

4.3.2 ASB Treatment System Evaluations and Improvements

In 2016, ABS Treatment System engineer evaluations and improvements were conducted to promote safe, reliable operations at the ASB Treatment System. ASB Treatment System engineering and evaluations were presented in the 2016 Annual Amendment to the RAWP (Atlantic Richfield, 2016a). During the 2016 LAS and ARWS, Atlantic Richfield completed the following improvements:

- Pond 4 Stairs Replacement;

- Hydrogen Gas Alarm Upgrade;
- Aspen Seep Collection Area Drainage Improvements;
- Ethanol Dosing Improvements; and
- Propane Generator Engine Replacement.

Each of these activities is described in further detail in the following subsections.

4.3.2.1. Pond 4 Stairs Replacement

The Pond 4 stairs were replaced due to observed rust and handrail damage, which could have potentially affected the structural integrity of the stairs. Performing the stair replacement required lowering of the pond water level; therefore, installation was conducted concurrently with sludge removal activities, which also require lowering of the pond water level. Removal of the old stairs occurred on August 30, 2016 and replacement stairs were installed on August 31, 2016. Refilling of Pond 4 began on September 6, 2016 once the Pond 4 stair launder assembly was installed. Water level in Pond 4 returned to normal operating levels on September 9, 2016 when discharge from Pond 4 resumed to Aspen Creek.

4.3.2.2. Hydrogen Gas Alarm Upgrade

There are two hydrogen gas alarms in the ASB battery room, which serve as Protective System Devices (PSDs). In order to reduce the amount of hydrogen gas present during battery charging and improve system safety conditions, the 50% lower explosive limit (LEL) hydrogen gas detector was replaced with the existing 20% LEL hydrogen gas detector and the former 20% LEL hydrogen gas detector was replaced with a 10% LEL hydrogen gas detector. The new 10% LEL alarm activates the ventilation fans and the new 20% LEL hydrogen alarm shuts down the generators. Hydrogen gas detector replacement and function testing was performed on May 27, 2016 in accordance with a MoC that was approved by Atlantic Richfield.

4.3.2.3. Aspen Seep Collection Area Drainage Improvements

Aspen Seep collection area drainage improvements were completed to enhance the flow of AD from the lower end of the Aspen Seep collection area to the v-notch weir inlet pipe for the ASB. The collection area is approximately 150 ft long by 21 ft wide and is comprised of 6-inch to 9-inch rounded rock wrapped in a geotextile fabric. The design of the collection area was intended to allow seep flow to infiltrate through the fabric and flow subsurface to the Aspen v-notch weir inlet pipe. Over time, the geotextile fabric and rock had become clogged with a hard red scale causing the matrix to become impermeable and water to flow on the surface of the matrix, rather than in the subsurface as originally designed. Drainage improvements completed during 2016 included exposing the geotextile fabric, cutting the geotextile fabric to expose the rock matrix, using an excavator bucket to breakup rocks that are scaled together, replacing the top layer of geotextile fabric, and installing three inches of one-inch crushed rock on top of the fabric. The drainage improvements were completed from the pipe feeding seep water into the weir box upstream approximately 75 ft long by 10 ft wide. Improvements completed during

2016 improved seep flow in this area allowing for the water flow subsurface within the rock matrix.

4.3.2.4. Ethanol Dosing Improvements

Ethanol is delivered to Manhole 1 by variable speed peristaltic pumps. Ethanol is typically added at a concentration of 0.5 mL of ethanol per liter of AS influent water (1.9 mL of ethanol per gallon of AS influent). Ethanol flow rates vary depending on influent flow rates and biocell performance. The current peristaltic pumps have a minimum flow rate of approximately 10 mL/min of ethanol. Due to decreases in AS flow rates during 2013 and 2014, the system has required ethanol flow rates as low as 3 mL/min to achieve optimal dosage. If the required flow rates cannot be achieved, overdosing can occur which will increase ethanol consumption. The excess ethanol will also cause the bacteria to reduce more sulfates into sulfide potentially inhibiting the bacteria's performance.

To achieve an acceptable flow rate, batch dosing with the peristaltic pump was completed through an update to the control program with additional inputs on the HMI for on-site personnel to make adjustments to the system.

4.3.2.5. Propane Generator Engine Replacement.

The ASB treatment system uses two 40 kilowatt propane generators to routinely charge the battery banks based on system power demands. During routine scheduled maintenance, it was determined that both generators needed to be replaced. Generator 1 was replaced with a new engine on August 24, 2016. The engine removed from Generator 1 was rebuilt and was used to replace the Generator 2 engine. In November, the Generator 2 engine was replaced with the spare engine due to a generator fault requiring engine warranty repair. The engine was fixed and will be re-installed as Generator 2 during the 2017 ARWS.

4.4 Materials Disposed of Off-Site

This section documents the Waste Materials disposed of off-site during 2016. A summary of 2016 waste manifests is presented in Table 6. Copies of the 2016 Waste Disposal Notification letters, waste profiles, waste manifests, and material reclamation documents are provided in Appendix B.

4.4.1 HDS Treatment System Sludge

As discussed in Section 4.2.2.4, the HDS Treatment System process produces a sludge which is dewatered in 25-cy roll-off style bins lined with non-woven filter fabric, and disposed off-site. In 2016, the HDS Treatment System filled six dewatering bins with sludge during the treatment season. A total of 50.46 tons (wet weight) of sludge were disposed off-site, with an approximate average percent solids of 26%, for a total of 13.1 tons of dry solids removed. Initial waste characterization samples of the sludge were collected on June 10, 2016. The sample procedures and analytical results are presented in Sections 5.2.3.3 and 6.1.5, respectively. The sludge, profiled as non-RCRA California hazardous waste, was transported under manifest by Ponder Environmental Services, Inc. to the US Ecology facility in Beatty, Nevada, for disposal.

4.4.2 ASB Treatment System Sludge

As discussed in Section 4.3.1.3, the ASB Treatment System generates sludge as part of the treatment process. During 2016, sludge was removed from the ASB Treatment System, dewatered, characterized for waste profiling purposes, and transported for disposal. Two 25-cy roll-off sludge dewatering bins were used to containerize approximately 13.5 tons (wet tons weight) of dewatered sludge for disposal off-site, with an approximate average percent solids of 12%, for a total of 1.6 tons of dry solids removed. Waste characterization samples of the sludge were collected on September 15, 2016 and additional sludge samples were collected on October 6, 2016 for percent moisture analysis. Sampling activities and sludge analytical results are described in Sections 5.2.3.3 and 6.2.5, respectively. The dewatered sludge, profiled as non-hazardous waste, was transported under manifest by Ponder Environmental Services, Inc. to the US Ecology facility in Beatty, Nevada, for disposal.

4.4.3 Miscellaneous Waste Material

Miscellaneous waste generated during operations of the HDS and ASB Treatment Systems are containerized and stored in the waste accumulation areas prior to transportation and disposal.

Miscellaneous waste generated during the 2016 field season includes:

- Used oil and oil filters;
- Oil impacted absorbent and rags;
- Waste buffer solution;
- Personal protective equipment (PPE), rags, and debris;
- Empty lime bags from HDS Treatment Plant operations;
- Used antifreeze;
- Diesel impacted soil;
- RI/FS investigation derived soil;
- Upper Pond Conveyance System (UPCS) asphalt pavement; and
- UPCS hydraulic oil impacted soil.

Waste sampling for characterization is described in Sections 5.2.1.1 and 5.2.1.2. Profiling, transportation, and disposal tasks for all miscellaneous waste at the US Ecology facility in Beatty, Nevada, were performed by Ponder Environmental Services, Inc. Used oil was recycled at DeMenno/Kerdoon, Inc. in Compton, California by Ponder Environmental Services, Inc.

Details on waste descriptions, classifications, quantities, and dates of waste removal from the site for the miscellaneous wastes are listed in Table 6.

5.0 2016 MONITORING ACTIVITIES

Treatment performance was monitored throughout the 2016 operation of the HDS and ASB Treatment Systems. The DQOs and sampling activities are described in the following sections.

5.1 Data Quality Objectives

Determination of treatment effectiveness and sludge disposal options requires that sufficient data of appropriate quality is gathered and evaluated. The DQOs for treatment related activities were established to ensure that the data collected are of sufficient quantity and quality for the intended use of the data. The specific DQOs are presented in Appendix C of the RAWP (Atlantic Richfield, 2013a). Similar to previous years, data collected during 2016 to support water treatment activities for the HDS and ASB Treatment Systems w as used to meet the following objectives:

- Evaluate the effectiveness, reliability and costs of certain collection and treatment techniques for interim water treatment while RI/FS investigations and final remedy selection proceeds;
- Verify that effluent from the treatment systems meets established discharge criteria;
- Evaluate the safety and reliability of the treatment systems for treating flows from the CUD, DS and AS;
- Evaluate treatment system modifications necessary to improve operations and provide continuous/seasonal discharge of treated water to Leviathan Creek and Aspen Creek;
- Assess the contingencies that must be considered during treatment system upsets; and
- Evaluate the chemical and physical characteristics and quantity of sludge from the treatment of the flows from the CUD, DS and AS for assessing disposal options.

5.2 Sampling and Analysis

The monitoring program implemented for the 2016 water treatment activities was designed to meet the objectives listed in Section 5.1 and was described in the Sampling and Analysis Plan (SAP) included in the RAWP and the RAWP Quality Assurance Project Plan (QAPP) (Atlantic Richfield, 2013a).

The following sections detail the sampling and analysis program used at the site during 2016.

5.2.1 Performance Monitoring Locations, Schedules, and Parameters

As described in the RAWP, water samples were collected for laboratory analysis at sample locations relevant to determining treatment technology effectiveness and reliability, as well as discharge compliance. Field monitoring data was collected at additional treatment process locations to evaluate the treatment system performance and make system adjustments as necessary. The performance monitoring and sampling groups are described below:

- *Regular Field Monitoring* includes field measurement of pH, dissolved oxygen (DO), oxidation/reduction potential (ORP), specific conductance, temperature, field measured iron speciation/concentration, and flow (where applicable).
- *Analytical Compliance Sampling* includes analytes, evaluated by laboratory methods, which are required for comparison with the discharge criteria listed in the MRAM and other analytes that are important in assessing treatment system performance and understanding of water quality.
- *Enhanced Sampling for Performance Monitoring* includes analytes, evaluated by field or laboratory methods, which are important for further optimization and process control of the ASB Treatment System, and are monitored only for ASB Treatment System waters.
- *Surrogate Field Parameter Monitoring* includes field measured pH and dissolved iron concentration and is used to evaluate HDS Treatment Plant effluent water quality for discharge suitability.

Treatment-generated sludge samples were also collected for laboratory analysis to determine waste characterization and profiling for disposal on an as-needed basis from the various solids collection areas. Sludge samples were analyzed for the solid-phase parameters outlined in Title 26 of the California Code of Regulations (CCR) and Code of Federal Regulations (CFR) including:

- Total threshold limit concentration (TTLC);
- Soluble threshold limit concentration (STLC);
- Toxicity characteristic leaching procedure (TCLP); and
- Synthetic precipitation leaching procedure (SPLP).

These parameters are also listed in Table 9. Additionally, sludge samples were analyzed for percent moisture and paste pH for use in future evaluations.

The 2016 HDS and ASB Treatment Systems sampling and analysis schedule are presented in Tables 7 and 8, respectively. These tables include sample locations, frequencies, and analytical parameters for samples collected in 2016. Table 8 includes the Enhanced Sampling for Performance Monitoring Schedule outlined in *Amendment #2 – 2013 Aspen Seep Bioreactor Treatment System Enhanced Sampling for Performance Monitoring, RAWP, Leviathan Mine, Alpine County, California* (Atlantic Richfield, 2013b). The 2016 summary of laboratory analytical methods for aqueous- and solid-phase parameters is presented in Table 9.

The sampling locations, schedules, and parameters for samples collected from the HDS and ASB Treatment Systems are described in Sections 5.2.1.1 and 5.2.1.2, respectively.

5.2.1.1. HDS Treatment System

During operation of the HDS Treatment System, laboratory samples and field parameter measurements were collected at four pre-designated sampling locations as illustrated on Figure 3. The influent sampling location is the in-line sample port on the discharge side of the Pond 4 influent pumps. The effluent sample location is the in-line sample port on the effluent tank recirculation line. The CUD and DS sample locations are at the discharge of each conveyance line prior to Pond 4.

During operation of the HDS Treatment System, *Surrogate Field Parameter Monitoring* was typically performed daily (once weekly at a minimum), and *Regular Field Monitoring* was performed weekly in accordance with the RAWP. *Analytical Compliance Samples* were collected on the following schedule:

- For the first four weeks of operation, abbreviated *Analytical Compliance Sampling* for HDS Treatment Plant effluent was conducted once per week; and
- During each month of operation, *Analytical Compliance Sampling* was conducted for HDS Treatment Plant influent, effluent, CUD, and DS.

As detailed in the RAWP, *Surrogate Field Parameter Monitoring* coupled with periodic confirmation sampling for laboratory analysis were used to confirm that the HDS Treatment System effluent met the discharge criteria. Surrogate field parameters were chosen because the field measurement of dissolved iron (measured as the total of Fe^{2+} plus Fe^{3+} species) with a Hach™ colorimetric test kit provides a direct measurement of discharge compliance with respect to dissolved iron. Additionally, HDS Treatment System historical data related to treatment of flows from the CUD and DS indicated that treated water with a pH above 7.2 s.u. results in effluent that consistently meets discharge criteria with respect to dissolved metals concentrations. Therefore, an effluent pH operating range of 7.5 to 8.5 s.u. with field measured dissolved iron of 1.0 milligram/liter (mg/L) or less was selected to provide a conservative surrogate parameter range for discharge compliance. The field monitoring and automated system monitoring has been shown to provide sufficient safeguards against discharging water that is outside of the discharge criteria listed in the MRAM (U.S. EPA, 2008).

Sludge waste characterization samples (described in Section 5.2.3.3) were collected directly from the dewatering bins prior to off-site disposal.

5.2.1.2. ASB Treatment System

During operation of the ASB Treatment System, laboratory samples and field parameter measurements were collected at the pre-designated sampling locations presented in Figure 6. *Analytical Compliance Sampling* performed at influent and effluent sample locations was conducted once a month, ex cept for the month of February because the site was inaccessible due to road conditions as described in Section 4.3.1.4. ASB Treatment System influent samples were collected at the Aspen weir, and effluent samples were collected at the end of the aeration channel when possible. During periods when snow or ice inhibited access to the end of the aeration channel, effluent samples were collected at the effluent flow meter, located at the head of the aeration channel.

Regular Field Monitoring was conducted at the influent and effluent stations, and at the active manholes, defined as manholes with process water flow, located throughout the ASB Treatment System. Water quality field parameters at manhole locations were used to assess the process conditions of the system. During the LAS, monitoring of field parameters was conducted at the same time as sample collection for laboratory analysis. During the ARWS, monitoring of field parameters was conducted weekly during normal ASB Treatment System operations and concurrently with *Analytical Compliance Sampling*.

During 2016, three *Enhanced Sampling for Performance Monitoring* events were conducted at the ASB Treatment System following the requirements outlined in *Amendment #2 – 2013 Aspen Seep Bioreactor Treatment System Enhanced Sampling for Performance Monitoring, RAWP, Leviathan Mine, Alpine County, California* (Atlantic Richfield, 2013b). During these events, *Regular Field Monitoring* was performed and samples were concurrently collected from active manholes. *Enhanced Sampling for Performance Monitoring* was always conducted at the same time as *Analytical Compliance Sampling* to maximize the data set from these events.

During sludge dewatering operations described in Section 4.3.1.3, treated filtrate water was discharged from the dewatering bins to Aspen Creek in accordance with the RAWP (Atlantic Richfield, 2013a). Discharge typically occurred daily and was conducted during working hours. *Analytical Compliance Sampling* of filtrate discharge water was conducted weekly from the discharge of the dewatering bins as a confirmation of field measurements. *Regular Field Monitoring* activities were conducted at least once daily during filtrate discharge. Samples were collected at the filtrate settling tank, immediately prior to starting discharge. Since water quality at the filtrate settling tank was consistently within discharge standards, all filtrate was discharged directly to Aspen Creek.

During the sludge dewatering activities, dewatered solids generated in the ASB Treatment System were sampled from each of the two sludge dewatering bins for laboratory analysis as described in Section 5.2.1. The sludge waste characterization samples were collected on September 15, 2016 and additional samples for percent moisture were collected on October 6, 2016. Disposal of the sludge is discussed in Section 4.4.2 and sludge sample results are presented in Section 6.2.5.

5.2.2 Additional Monitoring Locations, Schedules, and Parameters

In addition to the performance monitoring conducted at the HDS and ASB Treatment Systems, task specific monitoring was also performed. The task specific monitoring included initial Pond 4 characterization sampling. The sampling locations, schedules, and parameters for this task are described in the following section.

5.2.2.1. *Initial Pond 4 Characterization*

During spring commissioning of the HDS Treatment System, initial characterization of Pond 4 was performed by taking a grab sample at four discrete locations (P1, P2, P3, and P4), which were composited in the field and submitted for laboratory analysis. Results from the Pond 4 characterization sample are included in Tables D3 and D4 of Appendix D.

5.2.3 *Sampling Procedures*

Sampling procedures for the HDS and ASB Treatment Systems, are described in Standard Operating Procedures (SOPs) contained in the respective system O&M manuals (Atlantic Richfield, 2016g; Atlantic Richfield, 2016h), and the 2013 QAPP (Atlantic Richfield, 2013a). These documents were followed as guidance when obtaining field measurements and collecting samples for laboratory analysis. The sample and data collection procedures are described in the following sections.

5.2.3.1. *Flow Data*

The flows from the CUD and AS are directed through weirs for flow rate measurements on a continual year-round basis. The level in Pond 4 is measured and recorded by a stage gauge. Flow and stage monitoring equipment (weirs, gauge houses, bubblers, data recorders, etc.) at the CUD and AS and Pond 4 is the property of the LRWQCB. These facilities were formerly operated by the United States Geological Survey (USGS) for the LRWQCB. As of December 11, 2012, Atlantic Richfield began operating the flow monitoring equipment and downloading the flow data from the data loggers at these stations. Atlantic Richfield will continue to upload flow and stage level data collected from these stations to the project database in the future. During routine maintenance at the CUD weir on November 7, 2016, it was determined that the data logger malfunctioned. The cause was determined to be a faulty memory card and data on the card after October 5, 2016 (previous site visit) could not be recovered. The data logger was fixed and reinstalled during the February 1, 2017 site visit.

During operation of the CUD and DS collection and conveyance equipment in 2016, magnetic flow totalizers were used to monitor total volume and instantaneous flow rates for the captured flows from the CUD and DS.

During operation of the HDS Treatment System, the volume of untreated water pumped from Pond 4 into the HDS Treatment Plant was measured by a magnetic flow totalizer.
Three additional magnetic flow totalizers are installed underneath the clarifier tank; two for measurement of flow from the sludge recycle pumps and one for measurement of flow from the sludge waste pumps to provide operational process control.

At the ASB Treatment System, magnetic flow totalizers are used to measure the effluent and recirculation flows. Data from the magnetic flow totalizers is logged and stored by the SCADA/WIN-911 system. This data is transmitted to an off-site File Transfer Protocol (FTP) site daily. System flow rates are manually recorded during field monitoring events. Influent flow at the weir was measured weekly using a graduated bucket and timer during the ARWS and once per month during the LAS to obtain real time flow data for use in adjusting chemical feed dose rates. The weir data logger provides a more complete set of daily influent flow readings and is used for reporting AS flow in this report. Ethanol and NaOH dose rates are measured manually using a graduated cylinder and timer.

5.2.3.2. Water Quality Measurements and Sampling Procedures

When practicable, water quality field measurements were conducted in-situ using a field probe and meter capable of measuring pH, DO, temperature, specific conductivity, and ORP. These parameters were recorded on field measurement data sheets, which are provided in Appendix C. The field meter was calibrated at least once per sampling event, and the probe was decontaminated between each sample location. At locations or during times where in-situ measurement was not possible due to inaccessibility or health and safety hazards, a HDPE container was used to collect grab samples from which field parameters were measured and recorded. The HDPE container was triple-rinsed with sample water prior to the collection of each grab sample.

Field measurements for iron speciation/concentration were made using a Hach™ colorimetric test kit and Ha ch™ spectrophotometer. Hach™ vials for measurement of field iron were reused; however, each vial was decontaminated prior to each use.

Sample containers with appropriate preservatives for each analysis were provided by the contract laboratory. If no preservative was required, samples for laboratory analysis were collected directly into the containers provided by the laboratory. For samples requiring preservation, samples were collected in clean HDPE containers or new, disposable bailers and transferred to the preserved bottles.

Sample aliquots requiring field filtering were collected in clean HDPE containers or new disposable bailers and filtered through disposable 0.45-micron filters directly into the laboratory provided containers. A peristaltic pump was used to pump the samples through the filters. New filters and pump tubing were used for each sample.

HDS Treatment System effluent samples were collected as composite samples, each composed of three equal volumes, time-separated grab samples collected within one day. Each grab sample was preserved and filtered, as appropriate, immediately after collection. All other water samples were collected as discrete grab samples.

As part of the upcoming UPCS demonstration, samples were collected from Pond 1, Pond 2S, and Pond 2N on May 18, May 19, and May 20, 2016. Six discrete samples were collected from each pond (two depths at three locations around the pond) using a peristaltic pump and tubing attached to a telescoping pole. At each location a sample was collected from near the bottom of the pond and at the water surface to evaluate stratification based on laboratory analysis of acidity, field water quality parameters, and lime utilization rates. During sample collection, water quality parameters were measured using a calibrated YSI.

Following sample collection, one composite sample from each pond was prepared by obtaining equal volumes from each of the discrete samples collected from the pond (three samples total). Each composite sample was analyzed for Acidity, Calcium, and Sulfate by TestAmerica.

Lime utilization tests were performed on each grab sample and composite sample collected to assess variation in lime utilization rates. Based on the observed lime utilization rates and measured SEC of samples collected, additional grab samples (seven samples total) were collected and analyzed for Acidity by TestAmerica.

Field data and analytical laboratory reports are included in Appendix C.

5.2.3.3. Sludge Sampling Procedures

Sludge samples associated with operation of the HDS Treatment System and ASB Treatment System were collected directly from the dewatering bins prior to off-site disposal. Three-point composite sludge samples for waste characterization were collected using a decontaminated stainless steel trowel or PVC sampling pole, homogenized in a decontaminated stainless steel bowl, and transferred into unpreserved laboratory supplied 8-ounce glass jars. One composite sludge sample was collected from one HDS Treatment System dewatering and one composite sludge sample was collected from the two ASB Treatment dewatering bins. Sample jar lids were tightened to ensure that no change occurred to sample moisture content during shipping.

Three discrete grab samples for sludge moisture content were collected from the HDS Treatment System dewatering bin sampled from various locations within the bin. Four discrete grab samples for sludge moisture content were collected from the ASB Treatment System dewatering bin sampled from various locations within the two dewatering bins. Samples were collected using a stainless steel trowel or PVC sampling pole and were transferred into unpreserved laboratory supplied 8-ounce glass jars.

5.2.4 Sample Identification

Collected samples were immediately labeled with all required information using self-adhesive labels and waterproof ink. Sample labels included the following information:

- Project name;
- Site location;
- Sample identification code (see following explanation);
- Date and time of sample collection;
- Sampler's initials;
- Analysis required;
- Filtration, if required;

- Method of preservation, if used; and
- Sample matrix.

Each sample was assigned a unique identification code according to the sample location and sampling sequence. The three parts of the sample identification code are: (1) the sampling event sequence number; (2) the station designation; and (3) the sample sequence number (continuous for all stations within a treatment area) as outlined in the QAPP and treatment system specific SOPs. The sequence numbers are continued from year to year to eliminate the possibility of duplicate sample identifications. The sample identification code is recorded without space or symbols separating the three components.

The sample station designations generally follow the convention historically used at the site, with minor modifications to increase clarity. The station designations used in 2016 include:

- CUD – untreated water from the CUD;
- DS – untreated water from the DS;
- HDSINF – influent from Pond 4 (influent equalization basin), as it is pumped into the HDS Treatment Plant;
- HDSEFF – effluent from the HDS Treatment Plant, as it flows through the recirculation line on the effluent tank;
- HDSSLUDGE – sludge generated by the HDS Treatment Plant;
- PND4COMP – composite of untreated Pond 4 water taken from four locations around the Pond 4 perimeter (P1, P2, P3, P4);
- P1, P2, P3, P4 – northeast, southeast, southwest, and northwest locations around the Pond 4 perimeter;
- ASPINF – influent water from the AS, as it flows into the ASB Treatment System;
- ASPEFF – effluent from the ASB Treatment System or filtrate from sludge dewatering bin;
- ASPSLG – sludge generated by the ASB Treatment System;
- ASPMH# – manhole locations where process samples are collected within the ASB Treatment System (# symbol is replaced by the actual manhole number);
- Pond1 – samples collected around the perimeter of Pond 1;
- Pond2S – samples collected around the perimeter of Pond 2 South;
- Pond2S – samples collected around the perimeter of Pond 2 South; and
- OSP3 or OSP4 - samples collected in ASB Treatment System Ponds 3 or 4.

5.2.5 Laboratory Analytical Program

During 2016, treatment-related samples, including sludge, were sent to TestAmerica Laboratories, Inc. (TestAmerica), in Irvine, California for laboratory analysis.

5.2.6 Sample Collection and Quality Assurance/Quality Control

Upon collection, samples were labeled, logged on the chain- of-custody (COC), and kept in ice-chilled coolers until they were delivered to the analytical laboratory. Sample labeling and COC procedures were adhered to during sampling events to ensure the credibility and acceptability of analytical results. Samples remained in the custody of the field personnel until they were either transferred following COC protocol to a certified carrier for transport to TestAmerica. COCs were signed by each sample custodian. Samples were typically shipped within 24 hours of sample collection. All samples were analyzed within the acceptable hold times for analytes related to site discharge criteria.

Amec Foster Wheeler performed data verification on all laboratory analytical data. Approximately 24% of the sample sets were validated by a third party, Environmental Standards, Inc. (ESI), of Valley Forge, Pennsylvania meeting the minimum QAPP requirement (20%) for data validation. Upon request, data validation packages were prepared by the contract laboratory for evaluation. All laboratory data has been added to the site database, including data qualifiers representing any bias in the final data set which have been appended to the respective data and are presented in the data tables in Appendix D. In addition, field monitoring parameters for the treatment process stations have been added to the database to allow greater utility in evaluating process optimization and reliability.

Procedures for QA/QC are specified in the QAPP (Atlantic Richfield, 2013a). The QAPP was prepared in general accordance with the guidance provided in U.S. EPA QA/G-5, *U.S. EPA Guidance for Quality Assurance Project Plans* (U.S. EPA, 2002) and U.S. EPA QA/R-5, *EPA Requirements for Quality Assurance Project Plans* (U.S. EPA, 2001).

The QA/QC program consists of field and laboratory QA measures, testing of QC samples for both the field and laboratory, and data validation. A summary of the QA/QC measures for 2016 is provided below for each element of the QA/QC program.

5.2.6.1. Quality Assurance Measures

Field QA/QC consisted of using trained personnel for monitoring and sampling, operating and maintaining field devices in accordance with the manufacturer specifications, using standard field forms, and adhering to protocols required by the SAP and QAPP. The need for decontamination in the field was eliminated for water sample collection for laboratory analysis by sampling directly into the sampling container, or by using disposable equipment.

TestAmerica is certified by the California Environmental Laboratory Accreditation Program (ELAP). This laboratory has extensive SOPs, QA guidelines, and periodic laboratory-wide quality testing.

5.2.6.2. Quality Control Testing

Field QC samples consisted of the collection of field duplicates and field method blanks. As mentioned above, equipment rinse blank samples for water samples were not required, as disposable sampling equipment was used. The purpose of field duplicate samples was to test the precision of field sampling procedures. The purpose of field method blanks was to test whether field sampling procedures added any target analytes to the samples. The SAP specifies field QC samples be collected a minimum rate of 10% of the number of primary samples an d test methods. Field QC samples were labeled with sample station IDs (i.e., CUD, DS, HDSEFF, and ASPEFF) within the normal sampling event sequence in order to mask the identity of QC samples for the laboratory. A total of nine field duplicates and nine field method blanks were collected in conjunction with the compliance monitoring and sampling in 2016. Results for field duplicates and field method blanks are presented in Appendix D, Tables D-3, D-5, and D-7.

Laboratory QC samples were used primarily to determine if adjustments were needed to analytical equipment or procedures during analysis to obtain usable results, and secondarily, to test the quality of the final data set produced through standard QA practices and adjustments.

The following laboratory QC samples were analyzed for this study:

- Method blank;
- Laboratory control sample;
- Matrix spike and matrix spike duplicate (MS/MSD); and
- Laboratory duplicate.

TestAmerica provided the results for QC samples listed above with their laboratory reports included in Appendix E.

6.0 2016 MONITORING RESULTS

The following sections summarize the results of the Removal Action activities implemented by Atlantic Richfield during 2016, including CUD, DS, and AS treatment-related monitoring results and sample data QA/QC results. Treatment system data tables are presented in Appendix D. Laboratory data reports and COC forms are included in Appendix E.

6.1 CUD and DS Treatment Related Monitoring Results

The CUD and DS flows are treated by the HDS Treatment System. Several different aspects of the HDS Treatment System are evaluated when determining the overall performance. These include:

- The treated volume and flow rates;
- Performance monitoring;
- Mechanical performance;
- Consumable utilization; and
- Sludge generation.

Each of these aspects is described in detail below.

6.1.1 Treated Volumes and Flow Rates

During the 2016 treatment season, approximately 7.6 million gallons of water were treated and discharged by the HDS Treatment Plant. Approximately 5.0 million gallons of water from th e CUD and 2.2 million gallons of water from the DS were captured. Approximately 0.61 million gallons of water accumulated in Pond 4 during the previous winter season. A total of approximately 7.2 million gallons of CUD and DS water was collected in Pond 4 during 2016. Table 4 presents the monthly volume of water captured from the CUD and DS, which is based on the totalizer flow meters installed on the insulated and un-insulated CUD and DS conveyance lines. Table 4 also presents the monthly average flow rates of the CUD and DS which were calculated from the totalizer flow meter data. For comparison purposes, the CUD flow data as measured by the CUD weir is also included in Table 4.

The discrepancy between the total volume captured and collected in Pond 4 (approximately 7.8 million gallons) and the total volume discharged (approximately 7.6 million gallons) during the course of the treatment season is likely due to evaporation from Pond 4.

6.1.2 Performance Monitoring

In 2016, field surrogate monitoring and effluent compliance sampling results indicated that discharges of treated water from the HDS Treatment Plant did not exceed MRAM discharge criteria.

During 2016, direct discharge from the HDS Treatment System to Leviathan Creek occurred while effluent pH was between 7.9 and 8.6 and the dissolved iron concentration was below 1.0 mg/L. During discharge, field surrogate parameters were typically collected daily, and at a minimum once weekly, for field monitoring of pH and dissolved iron. If treated water did no t meet pH or dissolved iron discharge criteria (i.e. during upset conditions, or after restarting the HDS Treatment Plant following a short-term or long-term shutdown), the effluent was diverted back to Pond 4. System interruptions requiring the diversion of HDS Treatment Plant effluent to Pond 4 are described below in Section 6.1.3 and Table 14.

Samples of the CUD and DS, and the HDS Treatment Plant influent and effluent were collected for laboratory analysis in accordance with the schedule presented in the RAWP and summarized in Section 5.2.1.1. Results from the samples were included in the monthly progress reports to the U.S. EPA (Appendix A) and are also included in Appendices D and E. A summary of the minimum, maximum, and average constituent concentrations from the CUD and DS samples, and the HDS Treatment Plant influent and effluent samples compared to MRAM discharge criteria for 2016 is presented in Table 1 and Table 2, respectively.

6.1.3 Mechanical Performance

During 2016, non-routine maintenance and mechanical interruptions occurred that affected the operation of the HDS Treatment System, all of which were reported to U.S. EPA either very soon after the time of occurrence or in a monthly progress report. None of the incidents resulted in discharge of untreated water to Leviathan Creek, and capture of flows from the CUD and DS was maintained throughout the 2016 ARWS. A detailed summary of all of the incidents, including hourly downtime, is presented in Table 14.

6.1.4 Consumable Utilization

The HDS Treatment System uses several consumables both directly and indirectly throughout the treatment process, including diesel fuel, dry flocculant, freshwater, and lime.

- Approximately 14,015 gallons of diesel were used by the HDS Power Generation System to supply power to the HDS Treatment System and site office trailers. At the end of the 2015 treatment season, approximately 980 gallons were left on-site and used during spring commissioning in 2016. At the end of the 2016 treatment season, approximately 3,833 gallons of diesel were left on-site to facilitate spring commissioning in 2017. Diesel was used at an average rate of 67 gallons per day (gpd) during the ARWS and 74 gpd during the LAS.
- Flocculant was dosed at an average concentration of 0.89 parts per million (ppm) to promote solids settling in the HDS Treatment Plant clarifier. Approximately 57 lbs of dry flocculant were used.
- Approximately 15,538 gallons of freshwater were used for HDS Treatment Plant operations. Freshwater was used in the HDS Treatment Plant for cleaning lab ware, preparing flocculant solution, flushing pipelines, and pressure washing. Freshwater was

delivered by tanker truck to the site from a Gardnerville Water Stand. In addition, fresh water was used for hydrotesting the UPCS pipeline and other general construction activities.

- Lime was dosed at an average rate of 0.58 grams per liter (g/L) for treatment of HDS Treatment Plant influent. Approximately 18.6 tons of dry hydrated lime were used in 2016.

6.1.5 Sludge Generation

The HDS Treatment Plant generated a total of approximately 50.5 tons (wet weight) of sludge at an average rate of 6.6 tons of sludge per million gallons of treated water discharged. Dewatered sludge generated by the HDS Treatment Plant was sampled on June 10, 2016. The results of this sample are presented in Table 11. Results from the June 10, 2016 sludge sample did not exceed the Federal or California TCLP, TTLC, STLC, or pH thresholds, with the exception of the California STLC Nickel concentration threshold, and the sludge was classified as non-RCRA California hazardous waste. Disposal of the sludge is discussed in Section 4.4.1. The sample was also analyzed for percent moisture by weight. The average percent moisture of the sample was 74.0% (26.0% solids), resulting in a total of approximately 13.1 tons of dry solids generated.

6.2 ASB Treatment Related Monitoring Results

The AS flow is treated by the ASB Treatment System. Several different aspects of the ASB Treatment System are evaluated when determining the overall performance. These include the treated volume and flow rates, performance monitoring, mechanical performance, consumable utilization, and sludge generation. Each of these aspects is described in detail below.

6.2.1 Treated Volumes and Flow Rates

Approximately 2.10 million gallons of flow from the AS were treated by the ASB Treatment System during 2016, based on data from the Aspen v-notch weir and data collection system. Influent flow rates ranged from 1.31 to 33.17 gpm during 2016. A monthly summary of ASB Treatment System influent flow and treated volume is presented in Table 5.

6.2.2 Performance Monitoring

Performance monitoring for the ASB Treatment System includes evaluation of effluent water discharge compliance, ORP, sulfate removal, and ethanol consumption.

The concentration of dissolved metals in ASB Treatment System effluent did not exceed the MRAM discharge criteria for the site during the 11 compliance sampling events and five dewatering bin filtrate sampling events completed during 2016. A summary of 2016 minimum, maximum, and average constituent concentrations for the ASB Treatment System influent and effluent is presented in Table 3.

During 2016 sludge dewatering activities, the results of all filtrate water *Regular Field Monitoring* were within the desired range of surrogate parameters as referenced in the RAWP (pH between 7.2 and 9.0 and dissolved iron less than 1.0 mg/L). Filtrate sample analytical results indicate that discharged filtrate water was within the discharge criteria for all 2016 weekly sampling events.

In 2016, ORP measurements and sulfate removal data collected during *Regular Field Monitoring* and *Analytical Compliance Sampling* measurements confirmed satisfactory biological reduction of sulfate to sulfide. The ORP values reported for the biocell influent and effluent ranged between -173 and -408 millivolts (mV) with an average value of - 319 mV, indicating reducing to strongly reducing conditions generally appropriate for sulfate reduction. Target ORP values for biological sulfate reduction, and the ASB Treatment System biocells, are between -350 and -400 mV.

Sulfate removal was used as a measure of SRB activity and to estimate concentrations of sulfide available to precipitate dissolved metals from influent AD. Sulfate removal in 2016 averaged 47%, indicating good SRB activity. During 2016, the amount of sulfate removed typically exceeded the approximate 164 mg/L of sulfate conversion theoretically required to produce sufficient sulfide for precipitation of influent dissolved metals.

Consistent with historic data, analytical results from 2016 confirm that ethanol introduced to the ASB Treatment System is consumed during transport through Biocells 1 and 2 during the ARWS, maintaining the high level of biological activity demonstrated by good sulfate removal. The concentrations of nutrients are also monitored, but no adjustments were made to total nutrient addition rates during 2016 since the ASB Treatment System is performing well.

The low ORP, high sulfate removal, and ethanol consumption over several annual monitoring periods both indicate that reliable system operations and maintenance activities, including regular sludge removal, system optimization, and system improvements, have been successful in maintaining the performance of the ASB Treatment System.

6.2.3 Mechanical Performance

In 2016, mechanical incidents that affected the performance of the ASB Treatment System included power generation system upsets. These issues were resolved at the soonest practicable time in order to maximize treatment of flows from the AS. During many of the mechanical incidents, the ASB Treatment System was still partially operational, and none of the incidents resulted in discharge of untreated water to the aeration channel leading to Aspen Creek. A detailed summary of all of the mechanical incidents, including hourly downtime, is presented in Table 15.

6.2.4 Consumable Utilization

The ASB Treatment System uses several consumables both directly and indirectly throughout the treatment process, including NaOH, ethanol, TSP, urea, and propane. NaOH and ethanol are utilized in proportion to the volume of water treated, while TSP, urea, and propane usage is approximately constant from year to year. Chemical consumption rates during 2016 are described below.

- NaOH was dosed at an average rate of 1.09 milliliters per liter (mL/L) of influent. Approximately 2,278 gallons of NaOH were used in 2016.
- Ethanol was dosed at an average rate of 0.40 mL/L of influent. Approximately 847 gallons of ethanol were used in 2016.
- TSP was dosed at an average rate of 4.2 mg/L of influent. Approximately 88 cups of TSP were used in 2016.
- Urea was dosed at an average rate of 0.88 mg/L of influent. Approximately 22 cups of urea were used in 2016.
- Propane was used at an average rate of 14 gpd during the ARWS and 18 gpd during the LAS. Approximately 6,091 gallons of propane were used in 2016.

6.2.5 Sludge Removal

A total of approximately 13.5 tons (wet weight) of sludge was removed from the ASB Treatment System. Dewatered sludge from the ASB Treatment System was sampled on September 15, 2016. The results of this sample are presented in Table 12. Results from the September 15, 2016 sludge sample did not exceed the Federal or California TCLP, TTLC, STLC, or pH thresholds, and was classified as non-hazardous waste. Disposal of the sludge is discussed in Section 4.4.2. The sample was also analyzed for percent moisture by weight. The average percent moisture of the samples collected on September 15 and October 6, 2016 was 88.2% (11.8% solids), resulting in a total of approximately 1.6 tons of dry solids removed.

6.3 Quality Assurance/Quality Control Results

In accordance with the RAWP, all data were subject to data verification and a data quality review to evaluate completeness of the data set, performance results for field and laboratory QC samples, data validation results, and overall quality of the data set used to satisfy the compliance requirements. A subset of the data, approximately 24%, was subjected to additional validation, which was performed by ESI. The validation was performed in accordance with Section 5.2.6, and satisfies the minimum criteria (20%) set forth in the project documents. Data subject to this additional level of review was examined to determine compliance with the requirements specified in the published analytical methods, and the QAPP, according to the procedures described in *National Functional Guidelines for Inorganic Superfund Data Review* (U.S. EPA, 2010).

The data quality issues identified as a result of the data verification and validation are listed below.

- Reported positive results for acidity in samples 227HDSINF655 and 227HDSINF657 were flagged "J" and considered estimated due to the samples being analyzed beyond the holding time;
- Detection limit for total dissolved solids in sample 227HDSEFF656 may be higher than reported, and the "not-detected" result has been flagged "UJ" due to the sample being analyzed beyond the holding time;
- Reported positive results for magnesium in samples 227HDSEFF654, 227HDSINF655, 227HDSINF657, 259ASPEFF887, 259ASPINF888, 255ASPEFF879, and 255ASPEFF880 were flagged "J" and considered estimated due to a high percent difference being observed in the associated serial dilution analysis. Hardness results for these samples were also flagged "J" because hardness was calculated utilizing the estimated magnesium results;
- Reported positive result for aluminum in sample 246ASPEFF850 and zinc in sample 249ASPEFF864 were flagged "U" and considered "not-detected" due to the presence of aluminum and zinc in the associated laboratory blanks. If the sample result was less than the reporting limit (RL), the method detection limit (MDL) has been replaced by the sample result. If the sample result was greater than the RL, the RL and MDL have been replaced by the sample result;
- Reported positive results for ethanol in samples 259ASPEFF887, 259MH4891, and 259MH7893 were flagged "J -" and considered estimated (biased low) due to the samples being analyzed beyond the holding time;
- Reported positive results for sulfate in samples 259ASPEFF887, 259ASPINF888, 259MH2889, 259MH4890, 259MH4891, 259MH6892, and 259MH7893 were flagged "J-" and considered estimated (biased low) due to recoveries being less than 75% in the associated MS/MSD analyses;
- Reported positive results for dissolved nickel, dissolved copper, and dissolved zinc in samples 249ASPEFF864, 249ASPINF865, and 249ASPINF867 were flagged "J" (unless flagged "U") and were considered estimated due to high percent differences in the associated serial dilution analysis;
- Reported positive results for acidity in samples 249ASPINF865 and 249ASPINF867 were flagged "J" and considered estimated due to a large discrepancy between the field duplicate pairs; and
- Reported positive results for dissolved phosphorous in sample 235CUD691 was flagged "J+" (unless flagged "J") and considered estimated (biased high) due to phosphorous being present in the ICSA solution greater than 2x the MDL which indicates a possible positive interference in the presence of high levels of interferents.

The data quality issues are described in detail in the data QA/QC reports. Appropriate data qualifiers were added to the data in the site database and included in the tabulated data reporting in Appendix D. Any unverified data that was used in progress reporting was accompanied by an indication that the data was provisional. In summary, data was qualified when necessary due to occurrences of the following data quality issues noted for some analytes in some samples by ESI:

- Target analytes detected in laboratory blanks;
- Serial dilution imprecision;
- Field duplicate imprecision;
- Conducting analysis beyond holding times;
- Analyte interferences; and
- Low MS/MSD recoveries of target analytes.

Each QA/QC report summarizes sample results qualified due to bias. The QA/QC assessment reports produced by ESI are attached as Appendix G and are organized by laboratory work order number.

7.0 2016 SITE MAINTENANCE ACTIVITIES

This section summarizes maintenance activities conducted at the site in 2016, including general Pond 4 activities and road maintenance activities.

7.1 General Site Activities

Site operations improvements and construction activities completed in 2016 included Pond 4 area dust suppression and stormwater best management practices (BMP) maintenance.

7.1.1 Pond 4 Area Dust Suppression

On June 15, 2016, Envirotac II® was applied to the Pond 4 parking area and partially up the California and Nevada Access Routes to control and reduce on-site personnel exposure to dust. On June 6, 2016 Envirotac II® was applied along the Nevada Access Route residential area as described in Section 7.2.3.

7.1.2 Stormwater BMP Maintenance

Stormwater BMP inspections were performed in accordance with the 2013 RAWP (Atlantic Richfield, 2013a) throughout 2016. Based on the findings of these inspections, the following stormwater BMP maintenance activities were completed:

- Cleaning/restoring drainage ditches; and
- Cleaning/clearing culverts.

7.2 Road Activities

In April 2016, Atlantic Richfield submitted the *2016 Annual Road Operating Plan* (Atlantic Richfield, 2016d) to the United States Department of Agriculture (USDA) Forest Service in accordance with the USDA Forest Service Road Use Permit (USDA Forest Service, 2013). The permit, which was re-issued by the USFS in July 2013 to extend the termination date to December 31, 2018, allows Atlantic Richfield to conduct road maintenance (with certain provisions) on Leviathan Mine Road; also known as Forest Service Roads 10052 and 10348. Leviathan Mine Road consists of approximately 16 miles of mostly unpaved roads connecting the site to SR 89 and US 395. These roads are commonly referred to as the California Access Route, the Nevada Access Route, and the Aspen Access Route.

The major road activities completed in 2016 included road maintenance, road monitoring, and dust suppression. All road-related work was conducted to maintain safe and reliable access to the site, which is necessary for performing water treatment activities and related work in accordance with AOC requirements. During road work activities, traffic control and/or pilot cars were used to ensure the safety of the public, the road maintenance crews, and site workers.

7.2.1 *Road Maintenance*

Road maintenance completed in 2016 included routine surface grading and compacting, road crowning, and drainage improvements. Grading and compacting of the roadway surface was performed from approximately two miles west of US 395 in Nevada (past the area where dust suppressant was applied), through the site to SR 89 in California, including the portion of Leviathan Mine Road that stretches from the Nevada access gate to the AS access gate (Aspen Access Route); and grading select portions of the road throughout the year as necessary to reduce “wash boarding”. Drainage improvements included cleaning roadside ditches and culverts, and un -plugging culverts by removing accumulated rock, sediment, and weeds from around the upstream and downstream openings.

7.2.2 *Monitoring of Access Road Ground Deformation*

In 2010, Atlantic Richfield submitted the Leviathan Mine Road Stability Monitoring Plan to the USDA Forest Service (Atlantic Richfield, 2010) outlining the planned activities to evaluate the stability of an approximately 400-foot stretch of Leviathan Mine Road located just above the hair-pin turn on the Nevada Access Route approximately nine miles from US 395. The Road Stability Monitoring Plan was prepared in response to cracks observed in the road surface by Atlantic Richfield contractors in early August 2010.

During November 2010, three pairs of road monuments were installed along the approximate 400 foot stretch of road; the monument pairs were designated as 1A-1B, 2A-2B, and 3A-3B. Monuments with an “A” designation are located on the road shoulder adjacent to the top of the slope that descends to the west, and monuments with a “B” designation are located on the road shoulder adjacent to the toe of the slope which ascends from the road to the east. In May 2011, the reference distance between each pair of monuments was established by connecting a tape extensometer to the eye bolts and applying a standard tension to the tape. The vertical reference height between the tops of each monument pair was measured using a water level manometer. Subsequent readings have typically been taken monthly from approximately May to November in 2011, 2012, 2013, 2014, and 2015. In 2016, two readings were taken. All readings were compared to previous readings to monitor changes and identify potential movement trends. The horizontal and vertical differentials in reference to the May 2011 measurements were plotted as a function of time, and are included with the monument inspection data in Appendix F.

The vertical monitoring data for all three of the monument pairs shows variation in 2013 which is primarily attributed to measurement errors. Evaluation of the 2011 -2016 data for all three monument pairs (1A-1B, 2A-2B, and 3A-3B) indicates that little, if any, vertical movement is occurring.

Measurement of changes in distance, or approximate horizontal displacements between the monument pairs is completed using more precise instrumentation. The horizontal measurement data collected with the tape extensometer are less variable and less susceptible to error than the vertical measurement data collected with the manometers.

Overall, the tape extensometer measurement data compiled from 2011 to 2015 indicates that all three of the monument pairs showed an annual average expansion (average increased horizontal distance) between monuments from May to November that varied from approximately +0.2 inches between 1A- 1B, +0.5 inches between 2A-2B, and +0.5 inches between 3A-3B. In 2016, the monument pairs showed an expansion between monuments of approximately +0.2 inches between 1A- 1B, expansion of approximately +0.9 inches between 2A-2B, and an expansion of +0.3 inches between 3A-3B during the months of June through October.

The data from November through April-May for years 2011-2012, 2012-2013, 2013-2014, and 2014-2015 suggests that all three of the monument pairs showed an annual average contraction (average decreased horizontal distance) which varied from approximately - 0.1 inches between 1A-1B, -0.2 inches between 2A-2B, and -0.2 inches between 3A- 3B. In 2015-2016, the monument pairs showed contractions between monuments of approximately -0.1 inches between 1A-1B, approximately - 0.7 inches between 2A- 2B, and approximately -1.0 inches between 3A-3B during the months of November through May.

The cumulative changes in horizontal distance measured between the monument pairs between the baseline survey in May 2011 and the most recent survey conducted in November 2016 are +0. 813 inches between 1A-1B, +1.954 inches between 2A-2B, and +1. 232 inches between 3A-3B.

The survey data indicate that little to no relative vertical displacement is occurring across the roadway, and that the observed horizontal expansion is seasonally influenced. The data do not indicate imminent gross instability of the slope. However, due to the continuation of horizontal movements, we cannot preclude the possibility that the ongoing movements are related to instability of the slope. As such, we recommend that the monitoring program be continued at a minimum of two surveys annually. Surveys should be conducted at the beginning and the end of every field season. Additional surveys will be conducted when changes in site conditions are noted, such as the occurrence of significant earthquake or rainfall events, excessive widening of the cracks, erosion or fill placement in vicinity of the slope, or changes in groundwater conditions such as new areas of ponding or seepage in the vicinity of the slope.

7.2.3 Dust Suppression

In 2016, Nevada Access Route maintenance activities in the residential area included drainage maintenance and minor surface grading with a re-application of Envirotac II® for dust suppression. Surface grading activities were performed concurrently with preparation for reapplication of dust suppressant. Dust suppressant Envirotac II® was reapplied to the 1.75 mile stretch of the Nevada Access Route in front of the residences and in the Pond 4 parking area to prevent excessive dust generation on June 6, 2016 and June 15, 2016, respectively. This application was prepared and applied in accordance with the manufacturer's recommendations to the same general section of road as previous applications (applied annually from 2010 to 2015). A total of 1,650 gallons of Envirotac II® was applied.

8.0 STATEMENT OF COSTS INCURRED

The costs associated with the Removal Action activities conducted in 2016 are presented under the general cost categories described below. All reported costs were incurred in performing response actions related, either directly or indirectly, to the collection and treatment of AD as required under the AOC. The total approximate cost for the 2016 work completed was $5,022,000. The five-year average from 2012-2016 was $6, 356,000. A summary of the approximate costs incurred (rounded to $1,000 increments) is presented in Table 13.

8.1 Project Compliance, Reporting, Management, and HSSE Oversight

Project compliance, regulatory reporting, project management, and HSSE oversight activities were performed in support of ongoing work conducted for the site. These activities include:

- Updates to the HSSE Program Document and TSHASPs;
- Project management, scheduling, subcontractor cost tracking, and spend projections;
- Updating and managing the project database;
- HSSE support, on-site oversight, audits, training, and planning;
- Regulatory reporting and document preparation such as the RAWP, Spill Prevention, Control and Countermeasure Plan, Hazardous Materials Business Plans, Annual Road Operating Plan, Monthly Progress Reports, and the 2015 Annual Completion Report (Atlantic Richfield, 2016e);
- Non-regulatory reporting and documentation preparation such as the Site Operations Plan;
- Technical Summary Meeting presentation; and
- Agency communications and public relations support.

The total cost for the above project compliance, reporting, project management, and HSSE oversight activities in 2016 was $1,201,000.

8.2 Site Access

The total costs for site access related activities in 2016 were $537,000. The costs are broken down in the following subsections.

8.2.1 Site Setup and Maintenance

The total cost for site setup and maintenance in 2016 was $ 207,000. Included in this cost are the following activities:

- Rental of office trailers, furniture, portable restrooms, and trash receptacles during the field season;
- Potable drinking water brought to the site;
- Site communications such as satellite internet service, satellite phone service, and site radio equipment;
- Site management and coordination; and
- Purchase of safety related equipment such as Hydrogen Sulfide (H_2S) monitoring badges, multi-gas meters, air-escape packs, fire extinguishers, and first-aid kits.

8.2.2 Leviathan Mine Road Activities

The total cost for road maintenance in 2016 was $ 330,000. Included in this cost are the following activities:

- Surface grading and compacting of the Nevada and California Access Routes;
- Cleaning ditches and culverts along the Nevada and California Access Routes;
- Implementing temporary storm water controls at the ASB Treatment System;
- Performing road stability monument inspections at the hair-pin turn; and
- Applying dust suppressant on the Nevada Access Routes at the residential area and at the Pond 4 area.

8.3 CUD and DS Treatment Related Activities

8.3.1 HDS Treatment System

The total 2016 costs for HDS Treatment System operations and directly associated activities (including spring commissioning, operations and maintenance, sludge management and disposal, system winterization, engineering support, and system improvements) were $1,670,000. The five-year average from 2012-2016 was $2,116,400. The costs are broken down in the following subsections.

8.3.1.1. Spring Commissioning

The cost of spring commissioning and startup of the HDS Treatment System in 2016 was $133,000.

8.3.1.2. Operations and Maintenance

The total cost of O&M for the treatment of flows from the CUD and DS in 2016 was $1,094,000. The O&M activities associated with this cost included:

- Engineering oversight, geochemistry support, agency reporting, O&M assurance;
- Field logistics and daily routine O&M (including weekends) of the HDS Treatment System;
- HDS Treatment System O&M manual updates;
- HDS Treatment System consumables, including lime, polymer, and diesel;
- Mechanical and electrical maintenance, including major equipment repairs;
- Spare parts procurement;
- Performance monitoring and data evaluation; and
- Laboratory sample analysis and data validation.

8.3.1.3. Sludge Management and Disposal

As discussed in Section 4.4.1, the HDS Treatment System generated 50.46 tons (wet weight) of dewatered sludge which was disposed of off-site. The total cost for dewatering, characterization, transportation, and disposal of the HDS Treatment System sludge in 2016 was $58,000.

8.3.1.4. System Winterization

Winterization of the HDS Treatment System occurred in October 2016. The cost of winterization was $75,000, and included the activities described in Section 4.2.2.5.

8.3.1.5. Engineering Support and System Improvements

During 2016, HDS Treatment System engineering support and troubleshooting was conducted and various HDS Treatment System improvements were implemented. The cost associated with engineering support and system improvements was $ 310,000, and included the following activities:

- HDS Treatment System improvements as discussed in Section 4.2.3;
- HDS Treatment System troubleshooting; and
- Root cause analysis reports following system or equipment interruptions.

8.4 Aspen Seep Treatment Related Activities

8.4.1 ASB Treatment System

The total costs for ASB Treatment System operations and directly associated activities (including operations and maintenance, sludge management and disposal, engineering support, and system improvements) were $1,614,000. The five-year average from 2012- 2016 was $1,863,800. The cost is broken down in the following subsections.

8.4.1.1. Operations and Maintenance

The total cost of O&M for the treatment of flows from the AS in 2016 was $1,2 76,000. The O&M activities associated with this cost included:

- Engineering oversight, geochemistry support, agency reporting, O&M assurance;
- Weekly routine O&M during the ARWS;
- Monthly routine O&M during the LAS, including winter site visits;
- ASB Treatment System O&M manual updates;
- ASB Treatment System consumables, including NaOH, ethanol, and propane;
- Mechanical and electrical maintenance, including major equipment repairs;
- Spare parts procurement;
- Performance monitoring and data evaluation; and
- Laboratory sample analysis and data validation.

8.4.1.2. Sludge Management

During 2016, sludge management activities included biocell flushing, transfer of sludge from Pond 3 to Pond 4, and sludge removal. As discussed in Section 4.4.2, 13.5 tons (wet weight) of dewatered ASB Treatment System sludge was disposed of off-site. The cost of sludge management activities was approximately $165,000.

8.4.1.3. Engineering Support and System Improvements

During 2016, ASB Treatment System engineering support and troubleshooting was conducted and various ASB Treatment System improvements were implemented. The cost associated with engineering support and system improvements was $ 173,000, and included the following activities:

- ASB Treatment System improvements as discussed in Section 4.3.2;
- ASB Treatment System troubleshooting; and
- Root cause analysis reports following system or equipment interruptions.

9.0 UPCS CONSTRUCTION ACTIVITIES

During 2016, the construction on the UPCS began at the site. The purpose of the design and construction of the UPCS is to facilitate treatment of combined flows from the CUD, DS, PUD and Adit using the HDS Treatment System. T he UPCS was constructed to convey AD from the Upper Ponds (Pond 1, Pond 2S, and Pond 2N) to Pond 4. The UPCS construction activities completed in 2016 and as-built conditions are documented in the *Draft Upper Ponds Conveyance System Construction Completion Report* (Atlantic Richfield, 2016i). The report also presents construction scheduled for the spring of 2017 to complete the scope of work.

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TABLE 1
SUMMARY OF 2016 ANALYTICAL DATA FOR SAMPLES COLLECTED FROM THE CUD AND DS

Leviathan Mine Site
Alpine County, CA

Parameter	Units	Analytical Results[1,2,3]					
		Channel Underdrain			Delta Seep		
		Minimum[4]	Maximum[5]	Average[6]	Minimum[4]	Maximum[5]	Average[6]
Acidity, Total	mg/L	730	980	880	79	310	190
Alkalinity (Bicarbonate), Total	mg/L	< 4.8	< 4.8	2.4	< 4.8	< 4.8	2.4
Alkalinity (Carbonate), Total	mg/L	< 2.4	< 2.4	1.2	< 2.4	< 2.4	1.2
Alkalinity (Hydroxide), Total	mg/L	< 1.4	< 1.4	0.7	< 1.4	< 1.4	0.7
Alkalinity (Total), Total	mg/L	< 4.0	< 4.0	2.0	< 4.0	< 4.0	2.0
Aluminum, Dissolved	mg/L	29	49	38	4.3	43	24
Arsenic, Dissolved	mg/L	0.47	0.84	0.59	0.021	0.039	0.031
Cadmium, Dissolved	mg/L	< 0.0010	0.00040 J	0.0010	0.0013	0.0056	0.0036
Calcium, Dissolved	mg/L	230	290	260	280	340	310
Chloride, Total	mg/L	1.4	4.1	2.8	2.0	3.6	2.7
Chromium, Dissolved	mg/L	0.014	0.020	0.017	0.0011 J	0.0120	0.0066
Copper, Dissolved	mg/L	< 0.0020	0.0180	0.0090	0.063	0.45	0.26
Hardness, Dissolved	mg/L	830	990	900	1000	1200	1100
Iron, Dissolved	mg/L	310	380	350	10	17	12
Lead, Dissolved	mg/L	< 0.0010	< 0.0050	0.0011	< 0.0010	< 0.0010	0.00050
Magnesium, Dissolved	mg/L	58	67	63	79	100	89
Nickel, Dissolved	mg/L	1.2	1.7	1.4	0.43	0.74	0.58
pH, Field	s.u.	3.95	4.63	4.35	3.60	5.21	4.38
Selenium, Total	mg/L	< 0.010	0.0040	0.0030	0.0011 J	0.0064	0.0034
Sulfate, Total	mg/L	1600	2200	1900	1200	1700	1400
Total Dissolved Solids	mg/L	2700	3000	2900	1900	2400	2200
Total Suspended Solids	mg/L	11	63	31	16	48	30
Zinc, Dissolved	mg/L	0.19	0.34	0.28	0.14	0.50	0.33

Notes:

[1] Data from the CUD and DS was collected between May and October. Grab samples were collected for laboratory analysis.
[2] Constituents that were not detected are listed as "<" the reporting limit.
[3] Results noted with "J" are an estimated value or were less than the reporting limit but greater than or equal to the method detection limit.
[4] Minimum values represent the lowest detected concentration or "<" the reporting limit if the analyte was not detected.
[5] Maximum values represent the highest detected concentration or "<" the reporting limit if the analyte was not detected.
[6] Average values represent the calculated mean of concentrations during the sampling period. If the analyte was not detected during a sampling event, half of the reporting limit was used in the average calculation.

Abbreviations:

CUD – Channel Underdrain
DS – Delta Seep
mg/L – milligrams per liter
s.u. - standard units

TABLE 2
SUMMARY OF 2016 ANALYTICAL DATA
FOR SAMPLES COLLECTED FROM THE HDS TREATMENT PLANT
Leviathan Mine Site
Alpine County, CA

Parameter	Units	Analytical Results[1,2,3]						Discharge Criteria[8]	
		HDS Influent			HDS Effluent[4]				
		Minimum[5]	Maximum[6]	Average[7]	Minimum[5]	Maximum[6]	Average[7]	Maximum	Average
Acidity, Total	mg/L	220	740	550	< 2.0	< 2.0	1.0	NA	NA
Alkalinity (Bicarbonate), Total	mg/L	< 4.8	< 4.8	2.4	15	33	24	NA	NA
Alkalinity (Carbonate), Total	mg/L	< 2.4	< 2.4	1.2	< 2.4	< 2.4	1.2	NA	NA
Alkalinity (Hydroxide), Total	mg/L	< 1.4	< 1.4	0.7	< 1.4	< 1.4	0.7	NA	NA
Alkalinity (Total), Total	mg/L	< 4.0	< 4.0	2.0	13	27	20	NA	NA
Aluminum, Dissolved	mg/L	25	47	36	0.37	1.6	0.77	4.0	2.0
Arsenic, Dissolved	mg/L	0.0013	0.15	0.084	0.00051 J	0.0025	0.0015	0.3400	0.1500
Cadmium, Dissolved	mg/L	< 0.0050	0.0034	0.0022	< 0.0010	< 0.0010	0.0005	0.0090	0.0040
Calcium, Dissolved	mg/L	190	320	270	300	590	480	NA	NA
Chloride, Total	mg/L	1.9	4.0	2.9	1.9	2.9	2.5	NA	NA
Chromium, Dissolved	mg/L	0.0088	0.017	0.013	< 0.0020	< 0.0020	0.0010	0.9700	0.3100
Copper, Dissolved	mg/L	0.041	0.55	0.22	< 0.0020	0.0023	0.00098	0.0260	0.0160
Hardness, Dissolved	mg/L	720	1100	970	930	1800	1500	NA	NA
Iron, Dissolved	mg/L	2.1	160	120	< 0.040	0.013 J	0.032	2.0	1.0
Lead, Dissolved	mg/L	< 0.0010	< 0.0050	0.0007	< 0.0010	< 0.0010	0.00050	0.136	0.005
Magnesium, Dissolved	mg/L	57	80	72	43	78	66	NA	NA
Nickel, Dissolved	mg/L	0.51	1.3	0.99	0.0062	0.030	0.014	0.84	0.09
pH, Field	s.u.	2.32	3.71	2.84	7.93	8.94	8.33	NA	6.0-9.0
Selenium, Total	mg/L	< 0.010	0.0063	0.0043	0.00052 J	0.0039	0.0019	NA	0.0050
Sulfate, Total	mg/L	980	1800	1500	970	1800	1500	NA	NA
Total Dissolved Solids	mg/L	1400	2900	2400	1300	2800	2300	NA	NA
Total Suspended Solids	mg/L	< 10	100	26	< 10	16	9	NA	NA
Zinc, Dissolved	mg/L	0.21	0.40	0.29	< 0.020	0.0067 J	0.0046	0.21	0.21

Notes:
[1] Data was collected between May and October. Grab influent samples were collected for laboratory analysis.
[2] Constituents that were not detected are listed as "<" the reporting limit.
[3] Results noted with "J" are an estimated value or were less than the reporting limit but greater than or equal to the method detection limit.
[4] Effluent samples for laboratory analysis were collected as composite of three temporally separated grab samples throughout one day.
[5] Minimum values represent the lowest detected concentration or "<" the reporting limit if the analyte was not detected.
[6] Maximum values represent the highest detected concentration or "<" the reporting limit if the analyte was not detected.
[7] Average values represent the calculated mean of concentrations during the sampling period. If the analyte was not detected during a sampling event, half of the reporting limit was used in the average calculation.
[8] Discharge criteria and basis for maximum and average values are listed in the *Request for Approval of Modification to the Removal Action at the Leviathan Mine Memorandum* (US EPA, 2008).

Abbreviations:
HDS - High Density Sludge
mg/L – milligrams per liter
NA - Not Applicable
s.u. – standard units

TABLE 3
SUMMARY OF 2016 ANALYTICAL DATA
FOR SAMPLES COLLECTED FROM THE ASB TREATMENT SYSTEM

Leviathan Mine Site

Alpine County, CA

Parameter	Units	Analytical Results[1,2,3] ASB Effluent			Discharge Criteria[7]	
		Minimum[4]	Maximum[5]	Average[6]	Maximum	Average
Acidity, Total	mg/L	< 2.0	< 2.0	1.0	NA	NA
Alkalinity (Bicarbonate), Total	mg/L	130	560	410	NA	NA
Alkalinity (Carbonate), Total	mg/L	< 2.4	78.0	10.3	NA	NA
Alkalinity (Hydroxide), Total	mg/L	< 1.4	< 1.4	0.7	NA	NA
Alkalinity (Total), Total	mg/L	100	590	350	NA	NA
Aluminum, Dissolved	mg/L	< 0.050	0.45	0.16	4.0	2.0
Arsenic, Dissolved	mg/L	< 0.0010	0.0014	0.0011	0.34	0.15
Cadmium, Dissolved	mg/L	< 0.0010	< 0.0050	0.00086	0.009	0.004
Calcium, Dissolved	mg/L	110	230	177	NA	NA
Chloride, Total	mg/L	1.9	3.9	3.0	NA	NA
Chromium, Dissolved	mg/L	< 0.0020	< 0.010	0.0017	0.97	0.31
Copper, Dissolved	mg/L	< 0.0020	0.00093 J	0.0017	0.026	0.016
Hardness, Dissolved	mg/L	530	850	710	NA	NA
Iron, Dissolved	mg/L	< 0.040	0.23	0.065	2.0	1.0
Lead, Dissolved	mg/L	< 0.0010	< 0.0050	0.00086	0.136	0.005
Magnesium, Dissolved	mg/L	48	75	64	NA	NA
Nickel, Dissolved	mg/L	0.0034	0.071	0.026	0.84	0.094
pH, Field	s.u.	7.27	8.41	7.74	NA	6.0-9.0
Phosphorus, Dissolved	mg/L	< 0.0010	0.0014	0.0011	NA	NA
Selenium, Total	mg/L	< 0.0020	0.00060 J	0.0017	NA	0.005
Sulfate, Total	mg/L	420	1100	793	NA	NA
Total Dissolved Solids	mg/L	1200	2000	1600	NA	NA
Total Suspended Solids	mg/L	< 10	61	17	NA	NA
Zinc, Dissolved	mg/L	< 0.020	0.031	0.017	0.21	0.21

Notes:

1 Data was collected between January and December. Grab samples were collected for laboratory analysis.
2 Constituents that were not detected are listed as "<" the reporting limit.
3 Results noted with "J" are an estimated value or were less than the reporting limit but greater than or equal to the method detection limit.
4 Minimum values represent the lowest detected concentration or "<" the reporting limit if the analyte was not detected.
5 Maximum values represent the highest detected concentration or "<" the reporting limit if the analyte was not detected.
6 Average values represent the calculated mean of concentrations during the sampling period. If the analyte was not detected, half of the reporting limit was used in the average calculation.
7 Discharge criteria and basis for maximum and average values are listed in the *Request for Approval of Modification to the Removal Action at the Leviathan Mine Memorandum* (US EPA, 2008).

Abbreviations:

ASB - Aspen Seep Bioreactor
mg/L – milligrams per liter
NA - Not Applicable
s.u. – standard units

TABLE 4
2016 MONTHLY SUMMARY OF INFLUENT FLOWS FROM THE CUD AND DS AND TREATED VOLUME FROM THE HDS TREATMENT PLANT

Leviathan Mine Site
Alpine County, CA

Month in 2016	CUD: Average Monthly Flow (Weir) (gpm)[1,7]	CUD: Estimated Volume per Month (Weir) (gallons)[1,6]	CUD: Estimated Average Monthly Flow (Totalizer) (gpm)[2,3]	CUD: Estimated Volume Captured (Totalizer) (gallons)[2,3]	DS: Estimated Average Monthly Flow (Totalizer) (gpm)[2,3]	DS: Estimated Volume Captured (Totalizer) (gallons)[2,3]
January	10.20	455,202	--	--	--	--
February	12.92	539,612	--	--	--	--
March	19.78	883,195	--	--	--	--
April	27.95	1,207,388	--	--	--	--
May	28.55	1,274,347	29.05	652,661	16.01	359,844
June	29.31	1,266,203	27.44	1,145,964	12.13	506,501
July	23.47	1,047,489	24.87	1,074,242	9.88	426,735
August	19.07	851,073	22.52	1,005,141	8.90	397,369
September	14.43	623,245	20.12	869,162	8.39	362,361
October	--[8]	--	18.01	301,358	7.95	131,875
November	--[8]	--	--	--	--	--
December	--[8]	--	--	--	--	--
Total Est. Vol.	--	**8,147,755**	--	**5,048,528**	--	**2,184,685**
				Total CUD and DS Volume Captured	**7,233,213**	
				Approximate Initial Volume in Pond 4 on Startup[4]	**608,551**	
				Total Volume Discharged from HDS Treatment Plant[5]	**7,642,849**	

Notes:
All discharged water was treated. Discrepancy between water captured and discharged is assumed to be due to minor losses (i.e. evaporation).
[1] Data Source: Amec Foster Wheeler.
[2] Data Source: Field recording of volume totalizer reading on effluent flow meter from the CUD and DS collection and conveyance equipment. Total estimated volume per month and average monthly flow were calculated from volume totalizer readings.
[3] Flows from the CUD and DS were collected from May 16, 2016 through October 12, 2016.
[4] Volume in Pond 4 estimated from USGS gauge height of 5.82' on 5/16/16, minus the estimated Pond 4 sludge volume.
[5] Data Source: Total estimated volume per month and average monthly flow were calculated from effluent volume totalizer readings.
[6] Weir volume per month is estimated by multiplying the average monthly flow by the number of days in the month, 60 (to convert to hours), and 24 (to convert to days).
[7] Weir data is Draft - Provisional Data.
[8] No data available from October 5, 2016 through December 31, 2016 due to datalogger malfunction.

Abbreviations:
"--" = not applicable or not collected
CUD - Channel Underdrain
DS - Delta Seep
gpm - gallons per minute
HDS - High Density Sludge

TABLE 5
2016 MONTHLY SUMMARY OF INFLUENT FLOW AND TREATED VOLUME FROM THE ASPEN SEEP

Leviathan Mine Site
Alpine County, CA

Month in 2016	Minimum Daily Average Flow[1,3] (gpm)	Maximum Daily Average Flow[1,3] (gpm)	Average Monthly Flow[3] (gpm)	Total Estimated Volume Treated per Month[2] (gallons)
January	1.31	3.83	1.59	70,974
February	1.60	2.24	1.85	77,133
March	2.34	4.71	3.57	159,216
April	3.00	4.45	3.45	148,998
May	3.54	5.97	4.42	197,359
June	4.05	5.97	4.83	208,798
July	3.26	5.57	4.66	208,087
August	3.47	4.62	3.98	177,524
September	3.90	6.78	4.30	185,577
October	4.13	6.87	4.96	221,277
November	4.05	4.94	4.46	192,705
December	4.29	33.17	5.63	251,477
Total Estimated Treated Volume (gallons)			**2,099,124**	

Notes:
[1] Source: Amec Foster Wheeler
[2] Total estimated treated volume per month is calculated by multiplying the average monthly flow by the number of days in the month, 60 (to convert to hours), and 24 (to convert to days).
[3] Weir data is Draft - Provisional Data

Abbreviations:
ASB - Aspen Seep Bioreactor
gpm - gallons per minute

TABLE 6
SUMMARY OF 2016 WASTE MANIFESTS
Leviathan Mine Site
Alpine County, CA

Date Removed From Site	Profile Number	Manifest Number	Source	Waste Description	Classification	California Hazardous Waste Code	Container Size	Weight or Volume[1,2]
6/29/2016	070128300-8621	014654733 JJK	Site-Wide	Oily Debris	Non-RCRA Hazardous Waste, Solid	223	55 G	35 P
6/29/2016	070128300-9039	014654733 JJK	HDS Treatment Plant	Waste Buffer Solution	Non-RCRA Hazardous Waste, Solid	135	30 G	125 P
6/29/2016	070128043-8327	16-16166-001	Site-Wide	Used PPE	Non-Hazardous Waste, Solid	--	55 G	70 P
6/29/2016	070128043-8326	16-16166-001	Site-Wide	Empty Lime Bags	Non-Hazardous Waste, Solid	--	55 G	55 P
6/29/2016	070128043-8327	16-16166-001	Site-Wide	Used PPE	Non-Hazardous Waste, Solid	--	55 G	70 P
6/29/2016	--	014654734 JJK	Site-Wide	Used Oil	Non-RCRA Hazardous Waste, Liquid	221	30 G	30 G
7/11/2016	070209873-0	016012498 JJK	HDS Treatment Plant	HDS Sludge	Non-RCRA Hazardous Waste, Solid	491	25 CY	7.59 T
8/3/2016	070209873-0	16012483 JJK	HDS Treatment Plant	HDS Sludge	Non-RCRA Hazardous Waste, Solid	491	25 CY	7.75 T
8/16/2016	070209873-0	014654771 JJK	HDS Treatment Plant	HDS Sludge	Non-RCRA Hazardous Waste, Solid	491	25 CY	7.97 T
9/15/2016	070128043-8326	16-16166-002	Site-Wide	Empty Lime Bags	Non-Hazardous Waste, Solid	--	55 G	50 P
9/15/2016	070128043-8326	16-16166-002	Site-Wide	Empty Lime Bags	Non-Hazardous Waste, Solid	--	55 G	50 P
9/15/2016	070128043-8327	16-16166-002	Site-Wide	Used PPE	Non-Hazardous Waste, Solid	--	55 G	50 P
9/15/2016	070128043-8327	16-16166-002	Site-Wide	Used PPE	Non-Hazardous Waste, Solid	--	55 G	50 P
9/15/2016	070128300-9039	014654793 JJK	HDS Treatment Plant	Waste Buffer Solution	Non-RCRA Hazardous Waste, Solid	135	30 G	50 P
9/15/2016	--	014654794 JJK	Site-Wide	Used Oil	Non-RCRA Hazardous Waste, Liquid	221	55 G	50 G
9/15/2016	070128300-8621	014654793 JJK	Site-Wide	Oily Debris	Non-RCRA Hazardous Waste, Solid	223	30 G	75 P
10/26/2016	070245178-0	16-16251-004	Upper Pond Conveyance	Asphalt Pavement	Non-Hazardous Waste, Solid	--	2 x 25 CY	20.98 T
10/26/2016	070245178-0	16-16251-005	Upper Pond Conveyance	Asphalt Pavement	Non-Hazardous Waste, Solid	--	2 x 25 CY	20.27 T

TABLE 6
SUMMARY OF 2016 WASTE MANIFESTS
Leviathan Mine Site
Alpine County, CA

Date Removed From Site	Profile Number	Manifest Number	Source	Waste Description	Classification	California Hazardous Waste Code	Container Size	Weight or Volume[1,2]
10/26/2016	070231720-0	16-16211-001	ASB Treatment Plant	ASB Sludge	Non-Hazardous Waste, Solid	--	2 x 25 CY	13.51 T
10/26/2016	070209873-0	014654809 JJK	HDS Treatment Plant	HDS Sludge	Non-RCRA Hazardous Waste, Solid	491	2 x 25 CY	16.98 T
10/26/2016	070209873-0	014654810 JJK	HDS Treatment Plant	HDS Sludge	Non-RCRA Hazardous Waste, Solid	491	25 CY	10.17 T
11/1/2016	070128043-8327	16-16288-001	Site-Wide	Used PPE	Non-Hazardous Waste, Solid	--	55 G	50 P
11/1/2016	070128300-9039	014654807 JJK	HDS Treatment Plant	Waste Buffer Solution	Non-RCRA Hazardous Waste, Solid	135	30 G	200 P
11/1/2016	--	014654821 JJK	Site-Wide	Used Oil	Non-RCRA Hazardous Waste, Liquid	221	55 G	55 G
11/1/2016	070128300-8621	014654807 JJK	Site-Wide	Oily Debris	Non-RCRA Hazardous Waste, Solid	223	30 G	50 P
11/1/2016	070128043-8326	16-16288-001	Site-Wide	Empty Lime Bags	Non-Hazardous Waste, Solid	--	55 G	40 P
11/1/2016	070128043-12762	16-16288-001	RI	Investigaion Derived Soil	Non-Hazardous Waste, Solid	--	55 G	150 P
11/1/2016	409425DM	014654821 JJK	Site-Wide	Used Antifreeze	Non-RCRA Hazardous Waste, Liquid	343	30 G	30 G
11/1/2016	070128300-31493	014654807 JJK	HDS Treatment Plant	Diesel Contaminated Soil	Non-RCRA Hazardous Waste, Solid	352	30 G	150 P
11/1/2016	070128300-31492	014654807 JJK	Upper Pond Conveyance	Hydraulic Oil Impacted Soil	Non-RCRA Hazardous Waste, Solid	353	55 G	450 P
11/1/2016	070128300-31492	014654807 JJK	Upper Pond Conveyance	Hydraulic Oil Impacted Soil	Non-RCRA Hazardous Waste, Solid	353	30 G	450 P
11/1/2016	070128300-31492	014654807 JJK	Upper Pond Conveyance	Hydraulic Oil Impacted Soil	Non-RCRA Hazardous Waste, Solid	353	30 G	450 P

Notes:
[1] Weight and volume for treatment-generated solids recorded at disposal facility: US Ecology in Beatty, NV.
[2] P for pounds, G for gallons, Y for cubic yards, T for tons

Abbreviations:
"--" - Not Applicable
ASB - Aspen Seep Bioreactor
CY - cubic yards
G - gallons
HDS - High Density Sludge
P - pounds
RCRA - Resource Conservation and Recovery Act
RI = Remedial Investigation
T = tons

TABLE 7
2016 HDS TREATMENT SYSTEM SAMPLING AND ANALYSIS SCHEDULE

Leviathan Mine Site
Alpine County, CA

Monitoring Type	Location ID Code	Location Description	Analyses	Sample Collection Method	Frequency
Regular Field Monitoring[1,2]	CUD	Collected Channel Underdrain flow at the discharge of the conveyance line prior to Pond 4.	pH, DO, ORP, SEC, Temp, Dissolved Total Iron[3], Flow Rate/Volume	Field Probe and Meter[4,7]	1 x per month minimum
	DS	Collected Delta Seep flow at the discharge of the conveyance line prior to Pond 4.			1 x per month minimum
	HDSINF	Pond 4 water at the sample port on the discharge of the Pond 4 influent pump.			1 x per month minimum
	HDSEFF	Discharge of treated water from HDS Treatment Plant at effluent tank recirculation line sampling port.			1 x per week for the first four weeks of operation; 1 x per month thereafter
	P1, P2, P3, P4	Northeast, Southeast, Southwest, and Northwest locations around the Pond 4 perimeter.	pH, DO, ORP, SEC, Temp, Dissolved Total Iron[3]		1 x during spring commissioning
Surrogate Field Monitoring[2]	HDSINF	Pond 4 water at the sample port on the discharge of the Pond 4 influent pump.	pH, Turbidity, Dissolved Total Iron[3]	Field Probe and Meter[4]	pH: 1 x per week
	HDSEFF	Discharge of treated water from HDS Treatment Plant at effluent tank recirculation line sampling port.			prior to discharge; 1 x per week during discharge[5]
Analytical Compliance Sampling[1,2]	CUD	Collected Channel Underdrain flow at the discharge of the conveyance line prior to Pond 4.	Non-metals[8] (inorganics), Dissolved Metals[9], Total Selenium[10]	Grab	1 x per month
	DS	Collected Delta Seep flow at the discharge of the conveyance line prior to Pond 4.			1 x per month
	HDSINF	Pond 4 water at the sample port on the discharge of the Pond 4 influent pump.			1 x per month minimum
	HDSEFF[6]	Discharge of treated water from HDS Treatment Plant at effluent tank recirculation line sampling port.			1 x per week for the first four weeks of operation; 1 x per month thereafter
	P1, P2, P3, P4	Northeast, Southeast, Southwest, and Northwest locations around the Pond 4 perimeter.			1 x during spring commissioning
Waste Characterization	HDSSLUDGE	Three grab samples from three different sludge bins, or from three different locations between one or two sludge bins if three sludge bins are not available.	STLC, TCLP, TTLC, SPLP, DI-WET, Moisture Content[11], Dry Specific Gravity, Paste pH	Grab	1 x per year minimum

Notes:

1 Regular field monitoring shall be conducted at the time of any sample collection for laboratory analysis.
2 Dissolved Total Iron field monitoring is not required for CUD, DS, and HDSINF due to high iron concentration.
3 Dissolved Total Iron consists of a sample filtered through a 0.45 um filter and measured with the FerroVer HACH reagent or similar to obtain measure of the sum of ferrous and ferric iron concentrations or "total" iron concentration.
4 Dissolved Total Iron measured with a HACH Colorimetric Iron Field Test Kit.
5 In-line pH monitoring will occur continuously during periods of discharge.
6 A field composite sample will be prepared consisting of three temporally-separated grab samples over the course of one work day as the HDSEFF sample for laboratory analysis; filtration and preservation, as appropriate, of each grab sample will occur immediately following collection prior to preparing the field composite sample.
7 Flow Rate/Volume measured by in-line flow meter reading. Daily average flow rates will be calculated based on total gallons measured over a 24-hr period.
8 Non-metal (inorganic) analytes are acidity, alkalinity (bicarbonate, carbonate, and hydroxide), chloride, hardness, sulfate, total dissolved solids, and total suspended solids.
9 Dissolved metals analytes are aluminum, arsenic, calcium, cadmium, chromium, copper, iron, lead, magnesium, nickel, and zinc.
10 Total Selenium is considered equivalent to total recoverable selenium.
11 For moisture content, three grab samples are collected from three different sludge bins, or from three different locations between one or two sludge bins if three sludge bins are not available. All other analyses conducted on composite.

Abbreviations:
CUD – Channel Underdrain
DI – deionized water
DO – dissolved oxygen
DS – Delta Seep
HDS – High Density Sludge
NA – not applicable
ORP – oxidation-reduction potential
SEC - specific electrical conductance
SPLP – Synthetic Precipitation Leaching Procedure
STLC – Soluble Threshold Limit Concentration
TCLP – Toxicity Characteristic Leaching Procedure
TDS – total dissolved solids
Temp – temperature
TSS – total suspended solids
TTLC – Total Threshold Limit Concentration
USGS – U.S. Geological Survey
WET – Waste Extraction Test

TABLE 8
2016 ASB TREATMENT SYSTEM SAMPLING AND ANALYSIS SCHEDULE
Leviathan Mine Site
Alpine County, CA

<table>
<tr><th>Monitoring Type</th><th>Location ID Code</th><th>Location Description</th><th>Analyses</th><th>Sample Collection Method</th><th>Frequency</th></tr>
<tr><td rowspan="9">Regular Field Monitoring[1]</td><td>ASPINF</td><td>Seep Influent to system at pipe flowing into AS weir.</td><td rowspan="9">pH, DO, ORP, SEC, Temp, Total Iron and Iron Speciation[6], Flow Rate</td><td rowspan="9">Field Probe and Meter[4,5]</td><td rowspan="8">ARWS: 1 x per week minimum
LAS: 1 x per month[3]</td></tr>
<tr><td>ASPEFF</td><td>System Effluent at end of the Aeration Channel or Effluent Flow Meter[2.]</td></tr>
<tr><td>MH1 or MH2</td><td>Influent to Biocell 1 (Manhole 1 or 2).</td></tr>
<tr><td>MH3, MH4, or MH5</td><td>Influent to Biocell 2 (Manhole3, 4, or 5).</td></tr>
<tr><td>MH7 or MH9</td><td>Effluent from Biocell 2 (Manhole 7 or 9).</td></tr>
<tr><td>MH6</td><td>Confluence of biocell and AS influent water at the Pond 3 influent pipe.</td></tr>
<tr><td>OSP3EFF</td><td>Pond 3 water near decant structure on stairway.</td></tr>
<tr><td>OSP4EFF</td><td>Pond 4 water near decant structure on stairway.</td></tr>
<tr><td>ASPFEFF</td><td>Sludge dewatering effluent (filtrate) at discharge point.</td><td>Prior to discharge;
1 x per day during filtrate discharge</td></tr>
<tr><td rowspan="3">Analytical Compliance Sampling</td><td>ASPINF</td><td>Seep Influent to system at pipe flowing into AS weir.</td><td rowspan="3">Non-metals[8] (inorganics), Dissolved Metals[9], Total Selenium[10]</td><td rowspan="3">Grab</td><td rowspan="2">ARWS: 1 x per month
LAS: 1 x per month</td></tr>
<tr><td>ASPEFF</td><td>System Effluent at end of the Aeration Channel or Effluent Flow Meter[2.]</td></tr>
<tr><td>ASPFEFF</td><td>Sludge dewatering effluent (filtrate) at discharge point.</td><td>1 x per week during filtrate discharge</td></tr>
</table>

TABLE 8
2016 ASB TREATMENT SYSTEM SAMPLING AND ANALYSIS SCHEDULE
Leviathan Mine Site
Alpine County, CA

Monitoring Type	Location ID Code	Location Description	Analyses	Sample Collection Method	Frequency
Enhanced Sampling for Performance Monitoring[7,11,12]	ASPINF	Seep Influent to system at pipe flowing into AS weir.	Sulfate, Ethanol, Total Sulfide	Grab	ARWS: 1 x per quarter LAS: 1 x per quarter[3]
	ASPEFF	System Effluent at end of the Aeration Channel or Effluent Flow Meter[2.]			
	MH1 or MH2	Influent to Biocell 1 (Manhole 1 or 2).			
	MH3, MH4, or MH5	Influent to Biocell 2 (Manhole3, 4, or 5).			
	MH7 or MH9	Effluent from Biocell 2 (Manhole 7 or 9).			
	MH6	Confluence of biocell and AS influent water at the Pond 3 influent pipe.			
Waste Characterization	ASPSLG	Three grab samples from three different sludge bins, or from three different locations between one or two sludge bins if three sludge bins are not available.	STLC, TCLP, TTLC, SPLP, DI-WET, Moisture Content[13], Dry Specific Gravity, Paste pH	Grab	1 x per year minimum

Notes:
[1] Regular field monitoring shall be conducted at the time of any sample collection for laboratory analysis.
[2] During the LAS, the end of the Aeration Channel may be inaccessible due to snow or ice; therefore, the effluent flow meter is identi fied as an alternate sampling location.
[3] Sample locations may be omitted due to time or access constraints.
[4] A grab sample will be collected for laboratory analysis; filtration and preservation, as appropriate, of each grab sample wi ll occur immediately following collection.
[5] Flow rate measurements are only performed at the Aspen Seep (AS) weir and effluent flow meter locations.
[6] Field Iron measurements will not be performed at the ASPINF location due to high iron concentrations, except during Enhanced Sampling for Performance Monitoring events.
[7] For events occurring during the Limited Access Season, the enhanced sampling for optimization analyte list may be modified to exclude ethanol or other analytes, due to time constraints
[8] Non-metal (inorganic) analytes are acidity, alkalinity (bicarbonate, carbonate, and hydroxide), chloride, hardness, sulfate, to tal dissolved solids, and total suspended solids.
[9] Dissolved metals analytes are aluminum, arsenic, calcium, cadmium, chromium, copper, iron, lead, magnesium, nickel, and zinc.
[10] Total Selenium is considered equivalent to total recoverable selenium.
[11] Samples collected for ethanol and total sulfide are field filtered to remove particulate matter. Results for ethanol and tota l sulfide will be reported as total filterable result.
[12] Enhanced Sampling for Performance Monitoring is conducted quarterly according to Amendment #2 to the 2013 RAWP.
[13] For moisture content, three grab samples are collected from three different sludge bins, or from three different locations be tween one or two sludge bins if three sludge bins are not available. All other analyses conducted on composite.

Abbreviations:
ARWS – Atlantic Richfield Work Season
ASB – Aspen Seep Bioreactor
DI – deionized water
DO – dissolved oxygen
LAS – Limited Access Season
NA – not applicable
ORP – oxidation-reduction potential
SEC - specific electrical conductance
SPLP – Synthetic Precipitation Leaching Procedure
STLC – Soluble Threshold Limit Concentration
TCLP – Toxicity Characteristic Leaching Procedure
TDS – total dissolved solids
Temp – temperature
TSS – total suspended solids
TTLC – Total Threshold Limit Concentration
USGS – U.S. Geological Survey
WET – Waste Extraction Test

TABLE 9
2016 LABORATORY ANALYTICAL METHODS FOR AQUEOUS AND SOLID-PHASE PARAMETERS
Leviathan Mine Site
Alpine County, CA

Parameter	Sample Preparation or Type	Method	Method Detection Limit[1]	Method Reporting Limit[2]	Units
AQUEOUS-PHASE SAMPLES					
Anions and General Parameters					
Acidity	Unfiltered	SM 2310B	2.0	2.0	mg/L (as $CaCO_3$)
Alkalinity (Bicarbonate)	Unfiltered	SM 2320B	4.8	4.8	mg/L (as HCO_3^-)
Alkalinity (Carbonate)	Unfiltered	SM 2320B	2.4	2.4	mg/L (as CO_3^-)
Alkalinity (Hydroxide)	Unfiltered	SM 2320B	1.4	1.4	mg/L (as OH^-)
Alkalinity (Total)	Unfiltered	SM 2320B	4.0	4.0	mg/L (as CaCO3)
Chloride	Unfiltered	EPA 300.0	0.25	0.50	mg/L
Sulfate	Unfiltered	EPA 300.0	0.25	0.50	mg/L
Hardness	Filtered	SM 2340B	0.17	0.33	mg/L (as $CaCO_3$)
Total Dissolved Solids	Unfiltered	SM 2540C	5.0	10	mg/L
Total Suspended Solids	Unfiltered	SM 2540D	5.0	10	mg/L
Major Cations and Trace Metals					
Aluminum	Filtered	EPA 6010B	0.025	0.050	mg/L
Arsenic	Filtered	EPA 6020	0.00050	0.0010	mg/L
Calcium	Filtered	EPA 6010B	0.050	0.10	mg/L
Cadmium	Filtered	EPA 6020	0.00025	0.0010	mg/L
Chromium	Filtered	EPA 6020	0.00050	0.0020	mg/L
Copper	Filtered	EPA 6020	0.00050	0.0020	mg/L
Iron	Filtered	EPA 6010B	0.010	0.040	mg/L
Lead	Filtered	EPA 6020	0.00050	0.0010	mg/L
Magnesium	Filtered	EPA 6010B	0.010	0.020	mg/L
Nickel	Filtered	EPA 6020	0.00050	0.0020	mg/L
Phosphorus	Filtered	EPA 6010B	0.020	0.040	mg/L
Selenium	Unfiltered	EPA 6020	0.00050	0.0020	mg/L
Zinc	Filtered	EPA 6020	0.0025	0.020	mg/L
ASB Treatment System Enhanced Sampling					
Sulfate	Unfiltered	EPA 300.0	0.25	0.50	mg/L
Ethanol	Filtered	EPA 8260B	0.075	0.15	mg/L
Total Sulfide	Filtered	SM4500S2D	0.020	0.05	mg/L
SOLID-PHASE SAMPLES					
TCLP Metals	Sludge	EPA 1311/3010A/6010B/7470A	Varies	Varies	mg/L
SPLP Metals	Sludge	EPA 1312/3010A/6010B/7470A	Varies	Varies	mg/L
TTLC Metals	Sludge	EPA 6010B/7471A	Varies	Varies	mg/kg
STLC Metals	Sludge	CA WET DI/CA WET Citrate/EPA 6010B/7470A	Varies	Varies	mg/L
Paste pH	Sludge	DI Leach/SW-846 9045C	NA	NA	s.u.
Percent Moisture	Sludge	EPA Moisture	0.1	0.1	%

Notes:
[1] Method detection limits are the most conservative (largest) value from lab method blank analyses conducted in 2016.
[2] Method reporting limits are the lowest calibration standard used to calibrate the test. Reporting limits are based on lab instrument sensitivity, industry standards, and regulatory requirements.

Abbreviations:
ASTM – American Society for Testing and Materials
$CaCO_3$ – calcium carbonate
CO_3^- - carbonate
DI – deionized water
EPA – U.S. Environmental Protection Agency
HCO_3^- - bicarbonate
OH^- - hydroxide
mg/kg – milligrams per kilogram
mg/L – milligrams per liter
NA – not applicable
N – Nitrogen
SM – standard methods
SPLP – Synthetic Precipitation Leaching Procedure
STLC – Soluble Threshold Limit Concentration
s.u. – standard units
TCLP – Toxicity Characteristic Leaching Procedure
TTLC – Total Threshold Limit Concentration
WET – Waste Extraction Test

TABLE 10
SUMMARY OF 2016 HDS TREATMENT PLANT TREATED WATER DISCHARGE EVENTS

Leviathan Mine Site
Alpine County, CA

Month	Dates of Discharge	Estimated Volume of Discharge (gallons)[1]
May	5/10 - 5/31	1,246,155
June	6/1 - 6/27	1,713,709
July	7/13 - 7/31	1,432,181
August	8/1 - 8/21	1,261,029
September	9/29 - 9/30	1,163,616
October	10/1 - 10/12	826,159
Total 2016 Volume Discharged		7,642,849

Notes:
[1] Discharge volume is calculated from the influent flow totalizer while the HDS Treatment Plant discharge valve is open.

Abbreviations:
HDS - High Density Sludge

TABLE 11
SUMMARY OF 2016 HDS TREATMENT SYSTEM SLUDGE ANALYTICAL DATA
Leviathan Mine Site
Alpine County, CA

Parameter	Analytical Results[1,2,3,4]				Maximum Regulatory Threshold[5]		
	6/10/2016 232HDSSLUDGE674				TTLC (Total Metals) (mg/kg)	STLC (mg/L)	TCLP (mg/L)
	Total (mg/kg)	STLC (mg/L)	SPLP (mg/L)	TCLP (mg/L)			
Aluminum	15000 J	1200 J	1.7	0.45 J	NA	NA	NA
Antimony	< 20	< 0.20	< 0.20	< 0.20	500	15	NA
Arsenic	43	0.58	< 0.20	< 0.20	500	5.0	5.0
Barium	3.1	< 0.20	< 0.20	0.11 J	10000	100	100
Beryllium	2.4	0.22	< 0.080	< 0.080	75	0.75	NA
Cadmium	1.2	0.063 J	< 0.10	< 0.10	100	1.0	1.0
Chromium	5.5	0.28	< 0.10	< 0.10	500[6]	5 (560)[7]	5.0
Cobalt	180	14	< 0.20	0.15 J	8000	80	NA
Copper	120	9.4	< 0.20	< 0.20	2500	25	NA
Iron	44000 J	2000	< 0.80	< 0.80	NA	NA	NA
Lead	< 4.0	< 0.10	< 0.10	< 0.10	1000	5	5.0
Mercury	< 0.020	< 0.0020	< 0.00020	< 0.0020	20	0.2	0.2
Molybdenum	< 4.0	0.050 J	< 0.40	< 0.40	3500	350	NA
Nickel	390	**33 J**	0.022 J	0.34 J	2000	20	NA
Selenium	< 6.0	< 0.20	< 0.10	< 0.10	100	1.0	1.0
Silver	< 3.0	< 0.20	< 0.20	< 0.20	500	5.0	5.0
Thallium	< 20	< 0.20	< 0.10	0.16	700	7.0	NA
Vanadium	2.7	< 0.20	< 0.20	< 0.20	2400	24	NA
Zinc	130	4.0	< 0.40	< 0.40	5000	250	NA
pH (s.u.)	8.39				2.0-12.5		
Soil Moisture (% by weight)[8]	74.0				NA	NA	NA

Notes:
1 Constituents that were not detected are listed as "<" and the reporting limit is shown.
2 Results noted with "J" are an estimated value or were less than the reporting limit but greater than or equal to the method detection limit.
3 Results in bold exceed the corresponding criteria value.
4 In the case of a "U J" validated qualifier, results are shown as the reporting limit with a "J" qualifier.
5 Title 22 California Code of Regulations, Section 66261.24 (a)(2): Samples were tested for waste extraction test, solubility, and total concentrations. If the results of the STLC or TTLC equal or exceed their respective regulatory thresholds, the waste is a hazardous waste.
6 Concentration limit for total chromium and/or chromium (III) is 2500 mg/L and limit for chromium (VI) is 500 mg/L.
7 The federal hazardous waste level for soluble chromium is 5 mg/L. California has a Waste Extraction Test (WET) soluble level for chromium (III) (560 mg/L) and chromium (VI) (5mg/L). To use the 560 mg/L regulatory threshold, it must be demonstrated first that the waste is not a RCRA waste.
8 Percent Moisture is an average of the composite above and three moisture content samples (232HDSSLUDGE675, 232HDSSLUDGE676, and 232HDSSLUDGE677)

Abbreviations:
% – percent
HDS – High Density Sludge
mg/kg – milligrams per kilogram
mg/L – milligrams per liter
NA – not applicable
RCRA - Resource Conservation and Recovery Act
SPLP – Synthetic Precipitation Leaching Procedure
STLC – Soluble Threshold Limit Concentration
s.u. – standard units
TCLP – Toxicity Characteristic Leaching Procedure
TTLC –Total Threshold Limit Concentration

TABLE 12
SUMMARY OF 2016 ASB TREATMENT SYSTEM SLUDGE ANALYTICAL DATA
Leviathan Mine Site
Alpine County, CA

Parameter	Analytical Results[1,2,3,4]				Maximum Regulatory Threshold [5]		
	9/15/2016 254ASPSLUDGE877				TTLC (Total Metals) (mg/kg)	STLC (mg/L)	TCLP (mg/L)
	Total (mg/kg)	STLC (mg/L)	SPLP (mg/L)	TCLP (mg/L)			
Aluminum	6200	690	< 1.0	< 1.0	NA	NA	NA
Antimony	< 9.8	< 0.20	< 0.20	< 0.20	500	15	NA
Arsenic	< 2.9	< 0.20	< 0.20	< 0.20	500	5.0	5.0
Barium	15	0.93	0.061 J	0.57	10000	100	100
Beryllium	1.4	0.16	< 0.080	< 0.080	75	0.75	NA
Cadmium	< 0.49	< 0.10	< 0.10	< 0.10	100	1.0	1.0
Chromium	1.1	0.095 J	< 0.10	< 0.10	500[6]	5 (560)[7]	5.0
Cobalt	34	< 0.20	< 0.20	< 0.20	8000	80	NA
Copper	120	< 0.20	< 0.20	< 0.20	2500	25	NA
Iron	18000	580	< 0.80	160	NA	NA	NA
Lead	< 2.0	0.084 J	< 0.10	< 0.10	1000	5	5.0
Mercury	< 0.020	< 0.0020	< 0.0020	< 0.0020	20	0.2	.2
Molybdenum	< 2.0	< 0.40	< 0.40	< 0.40	3500	350	NA
Nickel	56	0.059 J	< 0.20	< 0.20	2000	20	NA
Selenium	< 2.9	0.17 J	0.081 J	< 0.10	100	1.0	1.0
Silver	< 1.5	< 0.20	< 0.20	< 0.20	500	5.0	5.0
Thallium	< 9.8	< 0.20	< 0.10	< 0.10	700	7.0	NA
Vanadium	0.88 J	0.060 J	< 0.20	< 0.20	2400	24	NA
Zinc	94	< 0.40	< 0.40	< 0.40	5000	250	NA
pH (s.u.)	7.5				2.0-12.5		
Soil Moisture (% by weight)[8]	88.2				NA	NA	NA

Notes:
[1] Constituents that were not detected are listed as “<” and the reporting limit is shown.
[2] Results noted with “J” are an estimated value or were less than the reporting limit but greater than or equal to the method detection limit.
[3] Results in bold exceed the corresponding criteria value.
[4] In the case of a "U J" validated qualifier, results are shown as the reporting limit with a "J" qualifier.
[5] Title 22 California Code of Regulations, Section 66261.24 (a)(2): Samples were tested for waste extraction test, solubility, and total concentrations. If the results of the STLC or TTLC equal or exceed their respective regulatory thresholds, the waste is a hazardous waste.
[6] Concentration limit for total chromium and/or chromium (III) is 2500 mg/L and limit for chromium (VI) is 500 mg/L.
[7] The federal hazardous waste level for soluble chromium is 5 mg/L. California has a Waste Extraction Test (WET) soluble level for chromium (III) (560 mg/L) and chromium (VI) (5mg/L). To use the 560 mg/L regulatory threshold, it must be demonstrated first that the waste is not a RCRA waste.
[8] Percent Moisture is an average of the composite above and four moisture content samples (254ASPSLUDGE878, 258ASPSLUDGE884, 258ASPSLUDGE885, and 258ASPSLUDGE886)

Abbreviations:
% – percent
ASB – Aspen Seep Bioreactor
mg/kg – milligrams per kilogram
mg/L – milligrams per liter
NA – not applicable
RCRA - Resource Conservation and Recovery Act
SPLP – Synthetic Precipitation Leaching Procedure
STLC – Soluble Threshold Limit Concentration
s.u. – standard units
TCLP – Toxicity Characteristic Leaching Procedure

TABLE 13
SUMMARY OF 2016 COSTS INCURRED
Leviathan Mine Site
Alpine County, CA

Task Description		
Project Management and Health, Safety, Security, and Environment (HSSE) Oversight		
Project Compliance, Reporting, Project Management and HSSE Oversight		**$1,201,000**
Site Access		
Site Setup and Maintenance		$207,000
Leviathan Mine Road Maintenance		$330,000
	Site Access Total	**$537,000**
HDS Treatment System Activities		
Spring Commissioning		$133,000
Operation and Maintenance		$1,094,000
Sludge Management and Disposal		$58,000
System Winterization		$75,000
Engineering Support and System Improvements		$310,000
	HDS Treatment System Activities Total	**$1,670,000**
ASB Treatment System Activities		
Operations and Maintenance		$1,276,000
Sludge Management and Disposal		$165,000
Engineering Support and System Improvements		$173,000
	ASB Treatment System Activities Total	**$1,614,000**
	Grand Total	**$5,022,000**

Notes:
Expenditures were rounded to $1,000 increments.

TABLE 14
SUMMARY OF THE 2016 HDS TREATMENT SYSTEM MECHANICAL PERFORMANCE
Leviathan Mine Site
Alpine County, CA

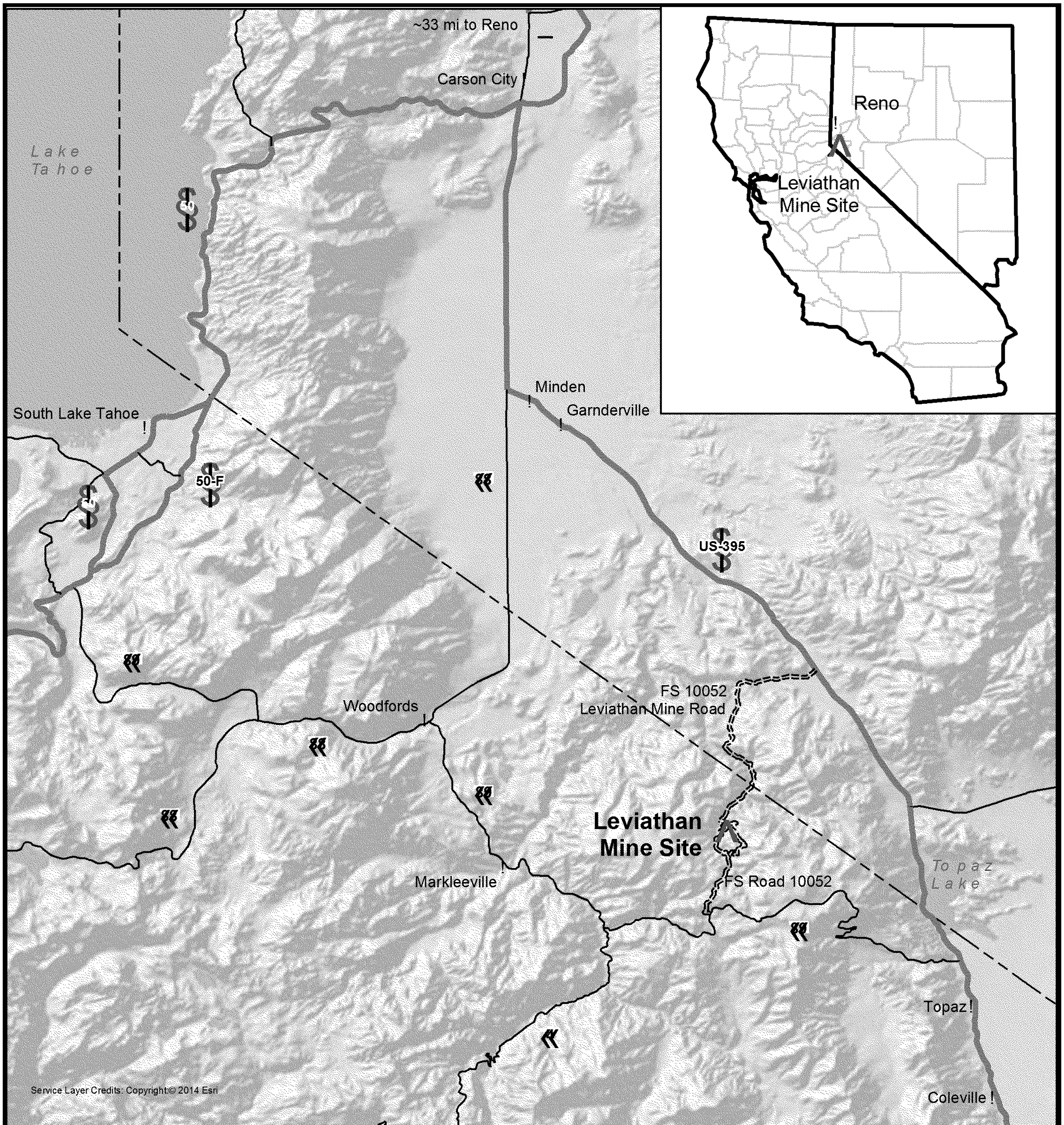
Date	System Downtime (Hours)	Interruption Details
5/12/2016	1.8	The HDS Treatment Plant was shutdown temporarily to replace a nipple on the effluent flow meter piping. The conveyance stations were not in operation at this time.
5/21/2016	2.7	The HDS Treatment Plant went into Recirculation Mode following a high effluent pH alarm. The pH probe in the reactor tank drifted out of calibration resulting in an increased lime dosage. The reactor tank pH probe was recalibrated and discharge to Leviathan Creek resumed once field water quality paramters wer confirmed and met discharge criteria. No loss of capture occurred.
8/5/2016	1.3	The HDS Treatment Plant was shutdown due to high effluent turbidity. A clog was found in a ball check valve on the dilution water line of the flocculant skid. The debris was removed and the system was returned to normal operation. There was no loss of collection at the CUD or DS conveyance stations.
8/25/2016	1.3	The HDS Treatment Plant shutdown due to a flow meter reading much higher than actual flow. The cause was determined to be a faulty signal from the flow meter. The power to the flow meter was reset and the system was returned to normal operation. There was no loss of collection at the CUD or DS conveyance stations.
10/3/2016	4.7	The HDS Treatment Plant shutdown due to low flocculant flow. The cause was determined to be flocculant pump PU-004B which needed to be rebuilt. The operating pump was switched to PU-004A, the system was returned to normal operation, and pump PU-004B was rebuilt. There was no loss of collection at the CUD or DS conveyance stations.
10/4/2016	6.3	The HDS Treatment Plant shutdown due to low flocculant flow. A cause for the trip was not determined. The plant was restarted and operators conducted troubleshooting on the flocculant skid. There was no loss of collection at the CUD or DS conveyance stations.
10/5/2016	0.0	A Victaulic™ grooved coupling on the discharge line of the DST pump failed resulting in a loss of conveyance between DST and Pond 4 from October 5, 2016 at approximately 13:30 until October 6, 2016 at approximately 10:30. The US EPA was notified on October 6, 2016. Capture at the DS tank on Leviathan Creek was maintained throughout this period, and pH readings in Leviathan Creek below the DS capture area did not indicate that any flow returned to Leviathan Creek from the DST area or that this incident otherwise affected surface water quality. A technical memorandum further explaining the background and mitigations was provided to the EPA on October 12, 2016. During this time, there was no downtime associated with the HDS Treatment System.
10/6/2016	3.9	The HDS Treatment Plant shutdown due to excessively high flow to the plant. The cause was determined to be the alarm set point of the maximum plant feed. The maximum plant feed was set to 5 gpm (lower than the minimum flow) and was anticipated to be caused by an accidental keystroke. The maximum feed rate was changed to an appropriate setting and the plant was restarted. There was no loss of collection at the CUD or DS conveyance stations.

Abbreviations
CUD: Channel Underdrain
DS: Delta Seep
DST: Delta Seep Transfer
HDS: High Density Sludge
gpm: gallons per minute

TABLE 15
SUMMARY OF THE 2016 ASB TREATMENT SYSTEM MECHANICAL PERFORMANCE
Leviathan Mine Site
Alpine County, CA

Date	System Downtime (hours)	Interruption Details
4/21/2016	7.5	The ASB Treatment System generators faulted due to an earthquake valve trip. The earthquake valve trip was due to an error in resetting the valve following PSD testing. Generators were restarted on April 22, 2016. There was no loss of capture at the Aspen Seep during this event.
7/2/2016	6.21	The ASB Treatment System shut down due to a 20% LEL H_2 Alarm. It was determined that the fan in the battery room was not functioning properly. The PLC programming was modified and sytem was function tested to ensure the fan in the battery room activates once the 10% LEL H2 alarm is triggered. There was no loss of capture at the Aspen Seep during this event.
7/3/2016	22.4	The ASB Treatment System shut down due to a 20% LEL H_2 Alarm. It was determined that the fan in the battery room was not functioning properly. The PLC programming was modified and sytem was function tested to ensure the fan in the battery room activates once the 10% LEL H2 alarm is triggered. There was no loss of capture at the Aspen Seep during this event.
8/23/2016	0	Discharge from the ASB Treatment System to Aspen Creek was halted on August 23, 2016 through Septemeber 9, 2016 to complete solids management and Pond 4 stair replacement activities. During this period ethanol and sodium hydroxide dosing was maintained.
9/22/2016	1.5	The ASB Treatment System was shut down for Battery Bank cell voltage checks. The battery bank inspections and voltage checks were completed and the system was returned to normal operation. There was no loss of capture at the Aspen Seep during this event.
10/4/2016	0.9	The ASB Treatment System was shut down due to an accumulation of precipitated solids in pre-treatment pond from normal operation. The pond was drained and the pipe to MH-1 was cleaned. There was no loss of capture at the Aspen Seep during this event.

Abbreviations
ASB: Aspen Seep Bioreactor
MH-1: Manhole 1
LEL: Lower Explosive Limit
SOP: Standard Operating Procedure



Legend

Road

Highway

Leviathan Mine Site

City or Town

State Route

Highway

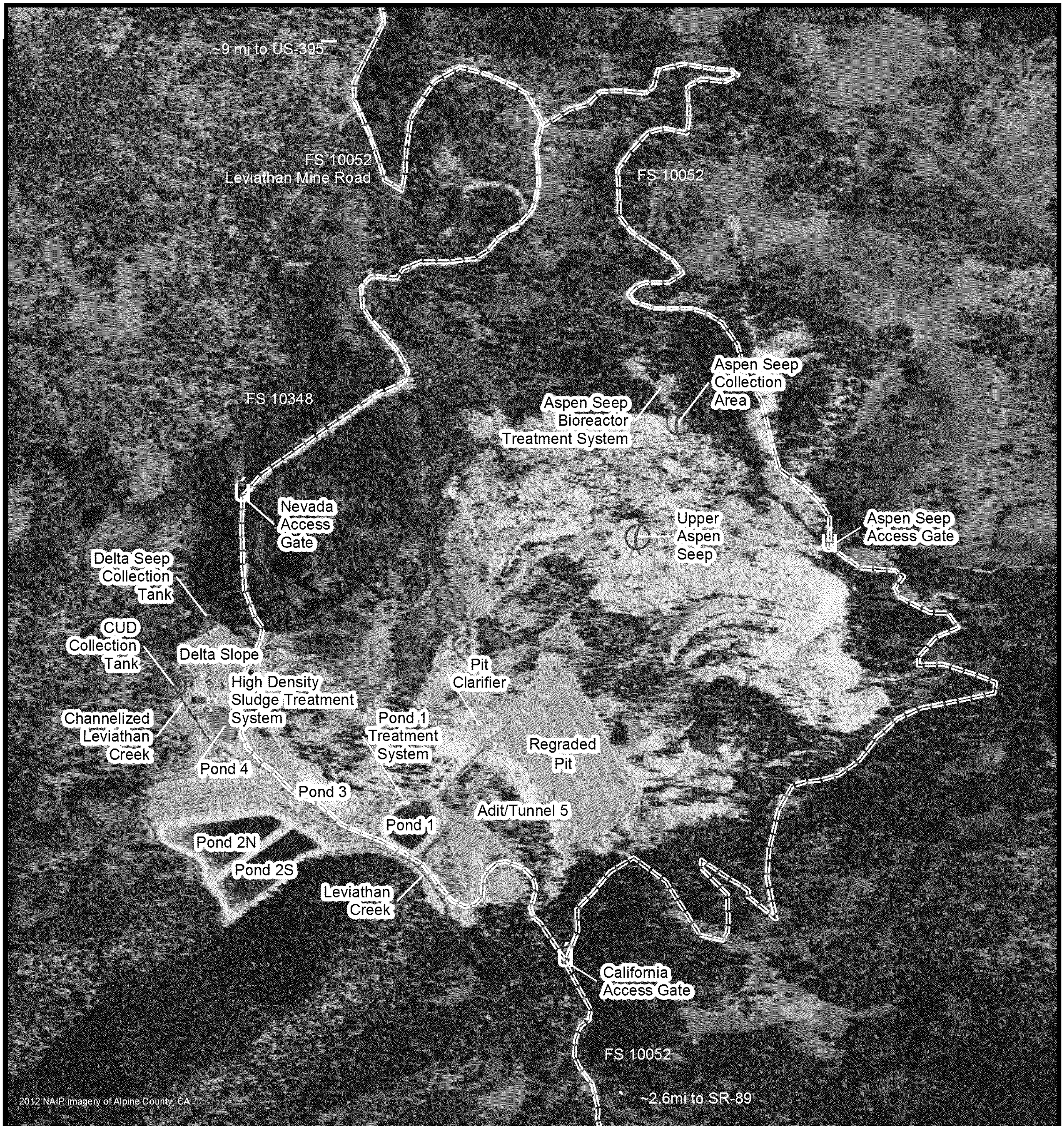
0 1.75 3.5 7 10.5 14 Miles

FIGURE 1

SITE LOCATION MAP

Copper Environmental Consulting

Date: 11/21/14	By: SS	Reviewed: MJ



Legend

Discharge Points

CUD Channel Underdrain
FS Forest Service
SR State Route
US United States Highway

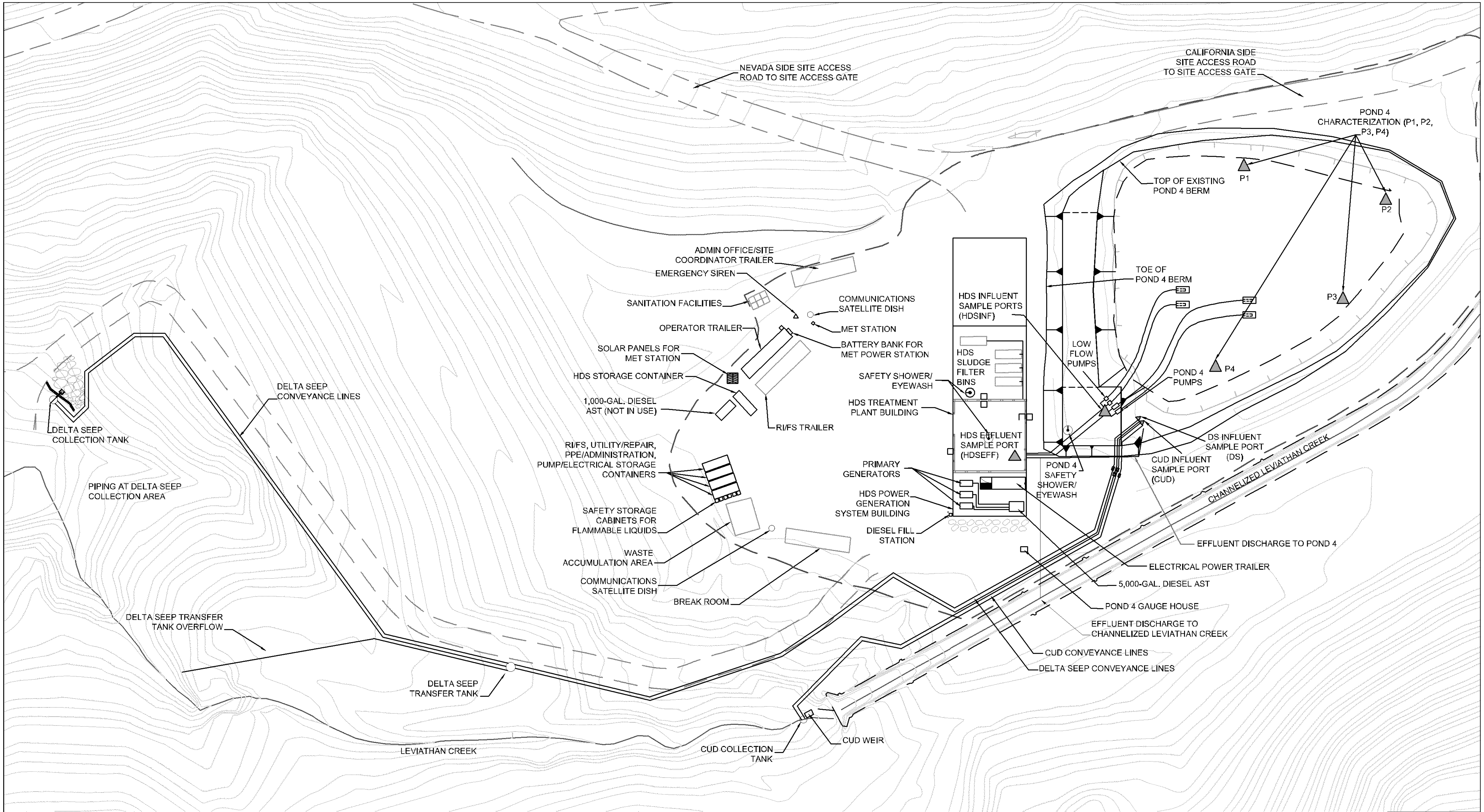
0 0.05 0.1 0.2 0.3 0.4 Miles

FIGURE 2

SITE LAYOUT

Copper Environmental Consulting

Date: 4/7/15	By: KP	Reviewed: MJ



No.	Date	By
0	12/3/14	SS

LEGEND:

- — — — POND 4 SITE WORK AREA
- ITEMS FOR TEMPORARY USE DURING THE TREATMENT SEASON
- ▲ SAMPLE LOCATION
- LEVIATHAN CREEK

AST	ABOVE-GROUND STORAGE TANK
CUD	CHANNEL UNDERDRAIN
GAL	GALLON
HDS	HIGH DENSITY SLUDGE
RI/FS	REMEDIAL INVESTIGATION/FEASIBILITY STUDY

Atlantic Richfield Company

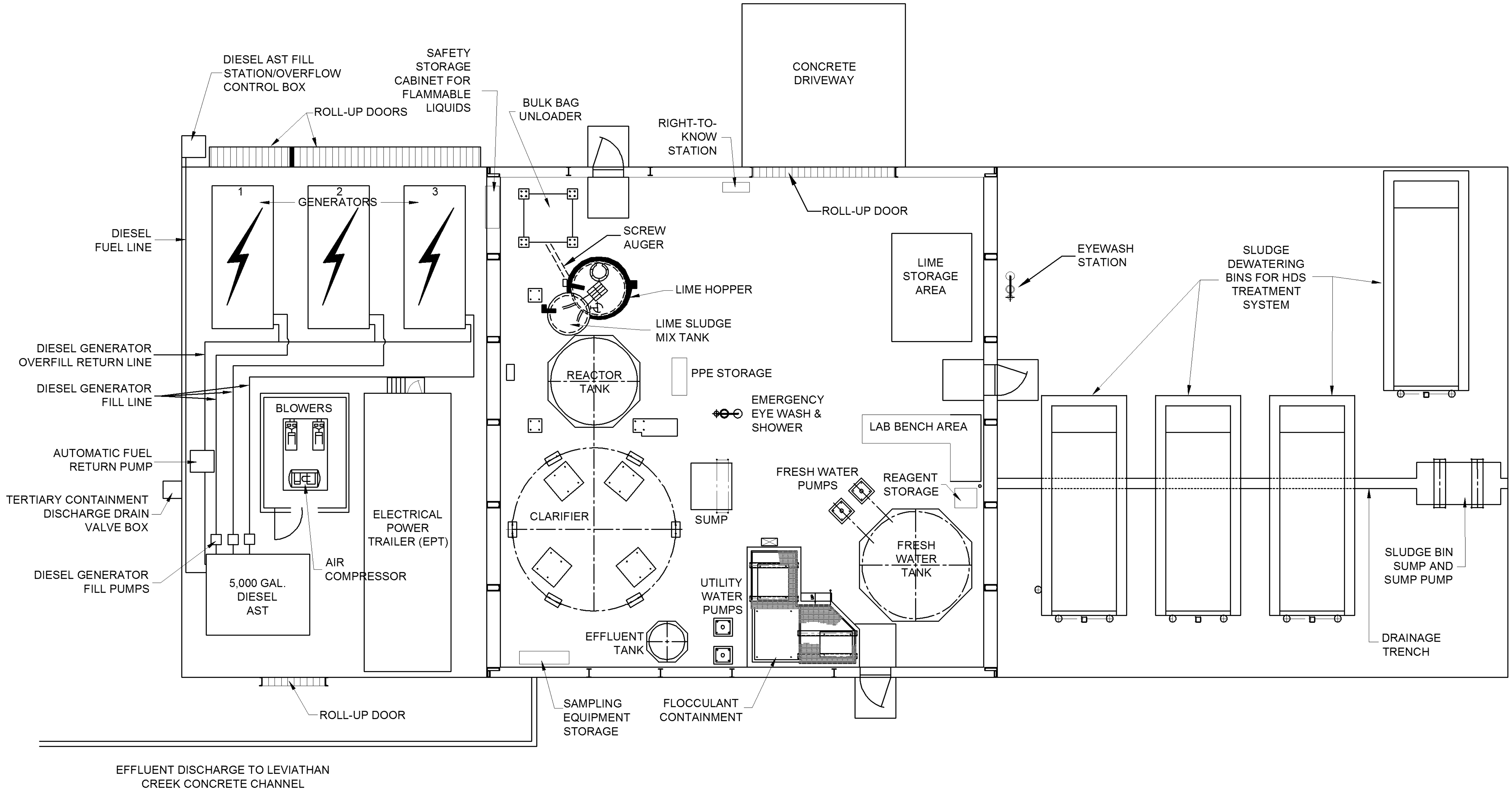
APPROXIMATE SCALE IN FEET

0 65

HDS TREATMENT SYSTEM LAYOUT
Leviathan Mine Site
Alpine County, California

FIGURE

3



NO.	DATE	BY	NOTES
-	03/07/11	AMEC	
-	04/15/14	CEC	STORAGE CABINETS NEAR EPT AND EYEWASH STATION ADDED
-	11/21/14	CEC	STORAGE CABINET

ABBREVIATIONS

HDS	High Density Sludge
AST	Above-Ground Storage Tank
PPE	Personal Protective Equipment

Atlantic Richfield Company

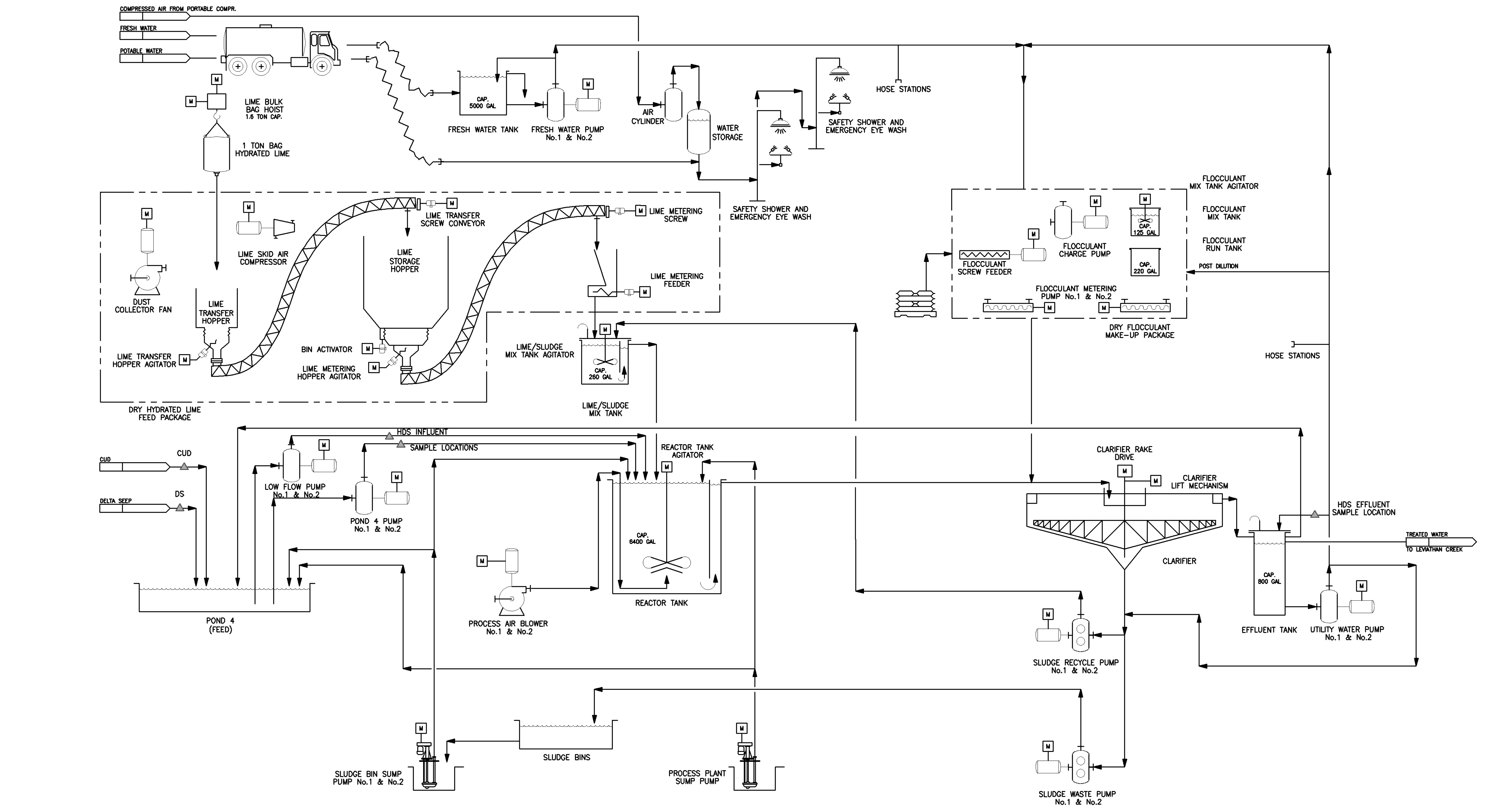
APPROXIMATE SCALE IN FEET

0 10

HDS TREATMENT PLANT EQUIPMENT LAYOUT
Leviathan Mine Site
Alpine County, California

FIGURE
4

ED_001709_00001406-00098



NO.	DATE	BY	NOTES
-	03/07/11	AMEC	

ABBREVIATIONS
CAP Capacity
CUD Channel Underdrain
DS Delta Seep
GAL Gallons
HDS High Density Sludge
▲ Sample Location

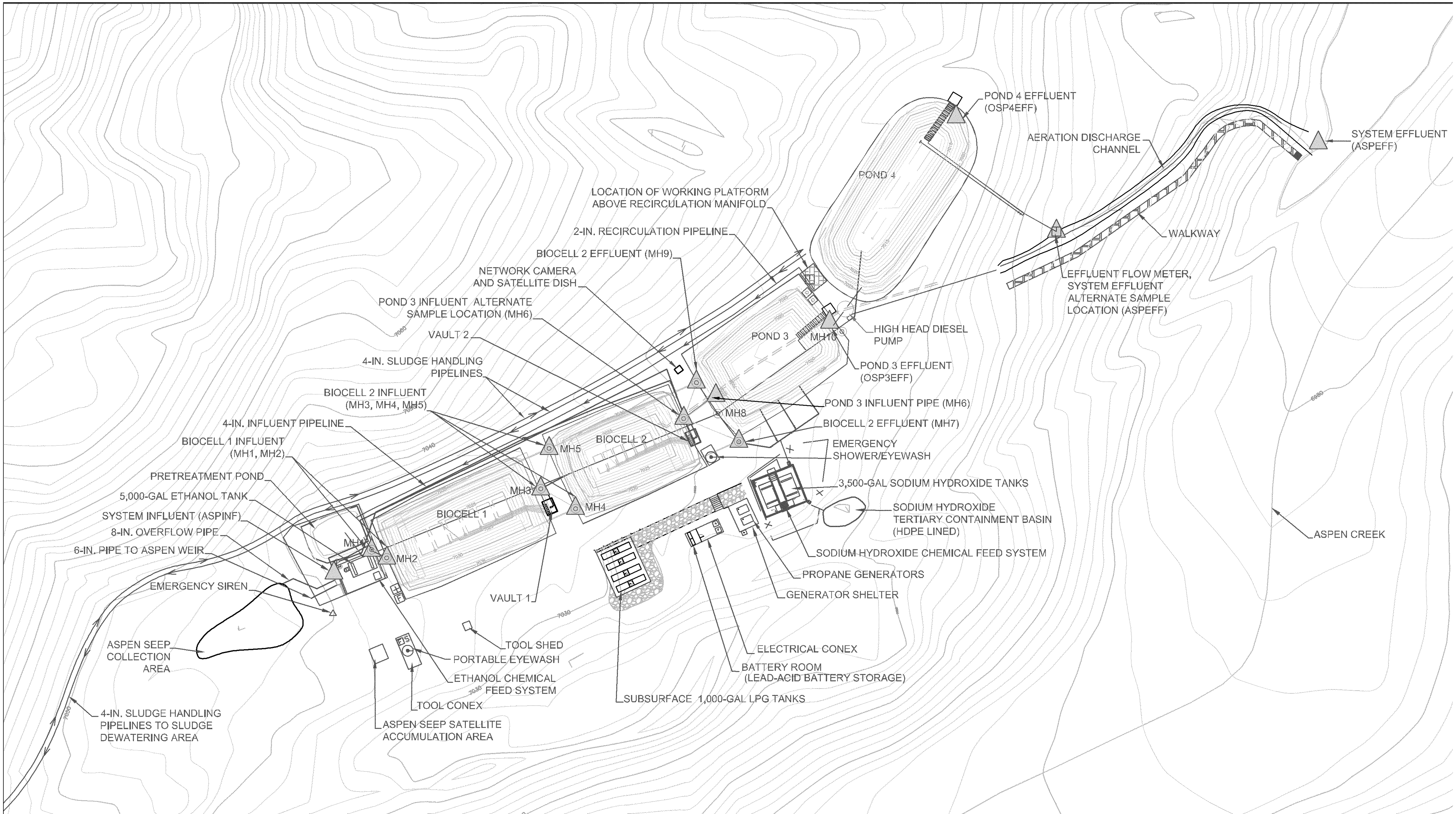
Atlantic Richfield Company

APPROXIMATE SCALE IN FEET
0 10

HDS TREATMENT SYSTEM
PROCESS FLOW DIAGRAM
Leviathan Mine Site
Alpine County, California

FIGURE
5

ED_001709_00001406-00099



No.	Date	By
0	02/14/13	DPV
1	02/25/15	SS

Legend

- Sample point
- Manhole
- Rock slope
- Submersible pump
- Flowmeter/totalizer
- First aid
- Spill kit
- Fire extinguisher
- Walkway

Abbreviations

ASB	Aspen Seep Bioreactor
IN.	Inch
MH	Manhole
GAL	Gallon

Atlantic Richfield Company

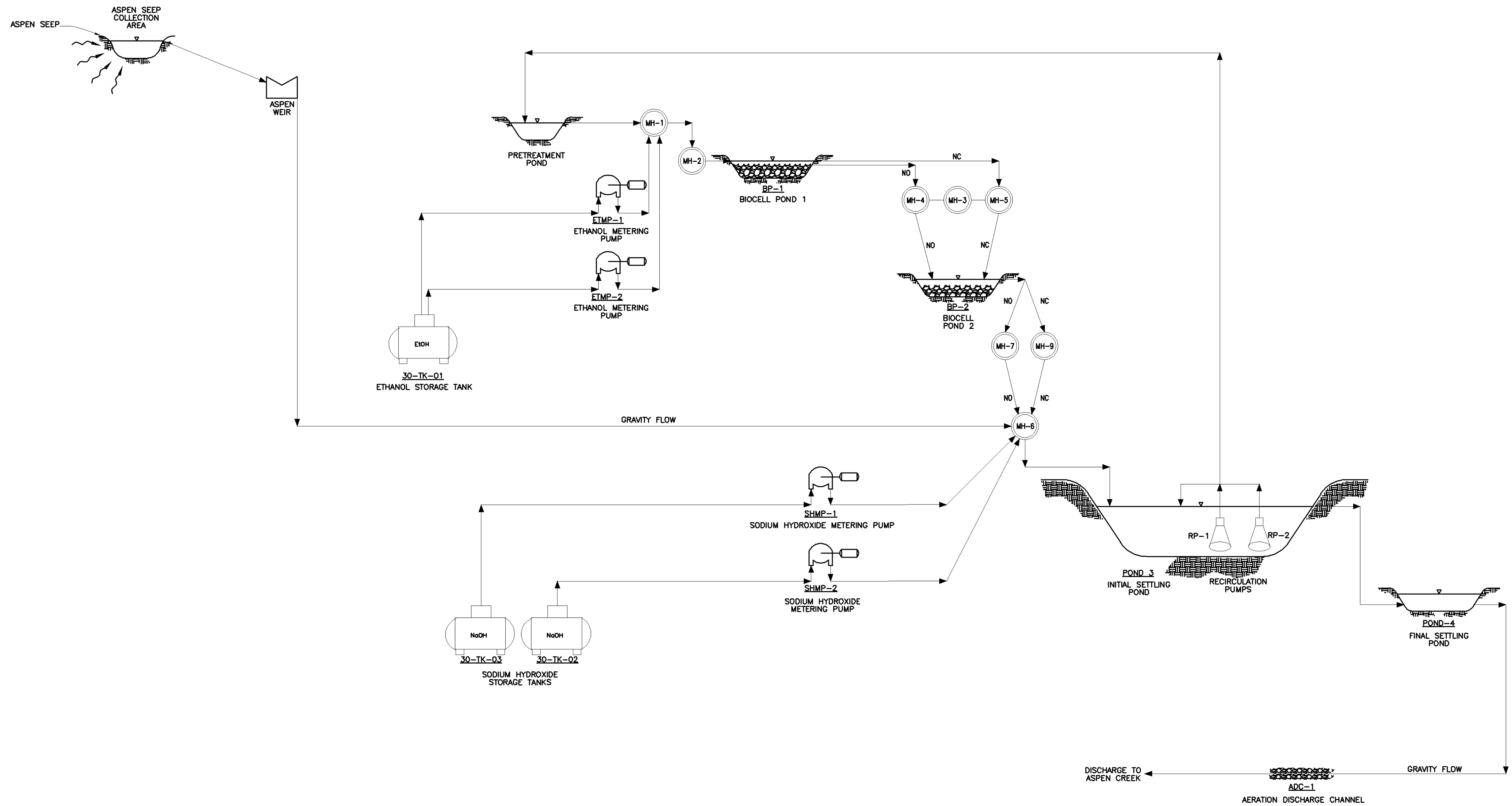
APPROXIMATE SCALE IN FEET

0 50

ASPEN SEEP BIOREACTOR
TREATMENT SYSTEM LAYOUT
Leviathan Mine Site
Alpine County, California

FIGURE

6



No.	Date	By
0	03/19/13	DPV

NOTES:

1. CONFIGURATION SHOWN AS FRONT TO BACK FLOW THROUGH BP-1 AND BP-2.

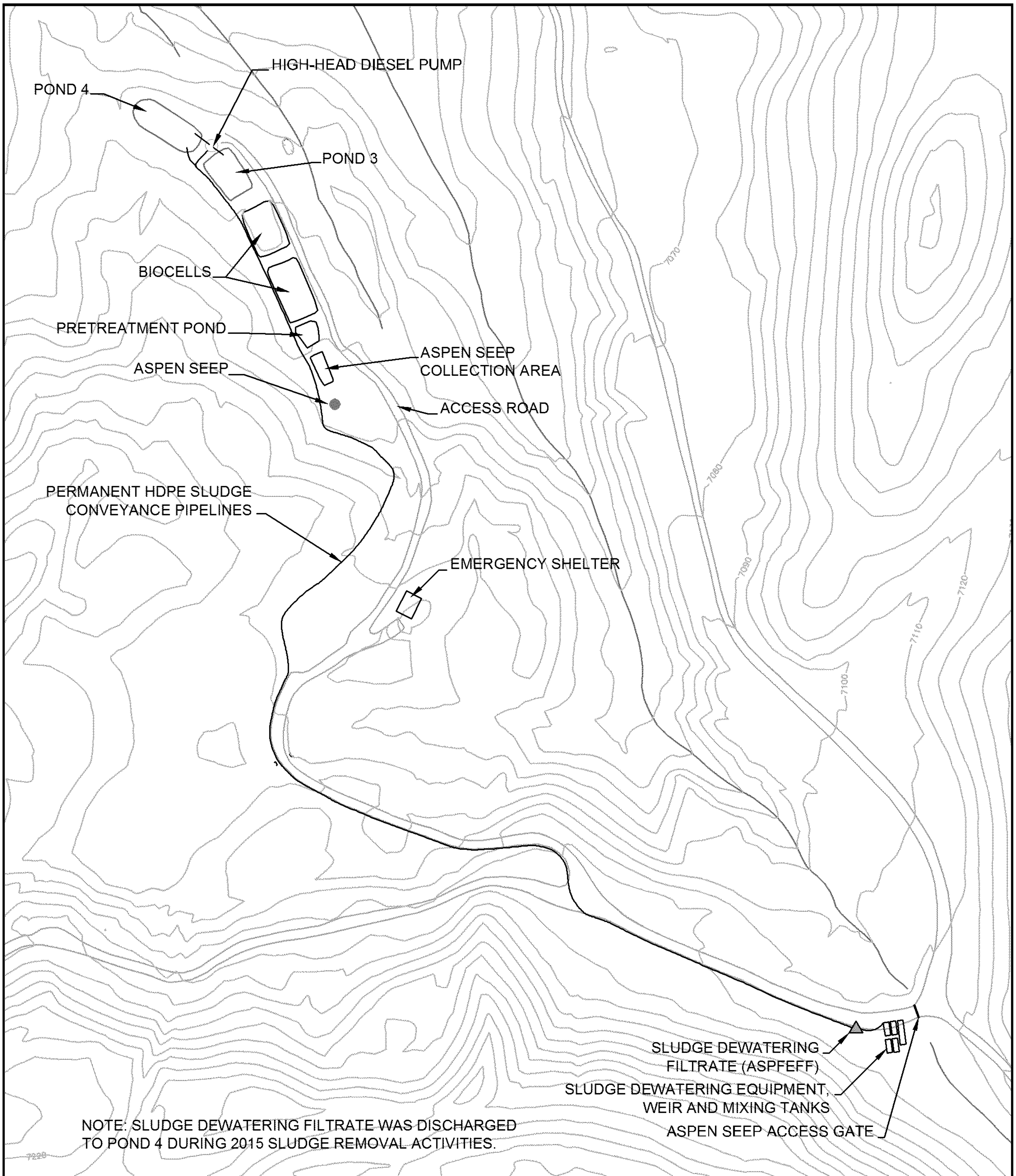
ABBREVIATIONS:

NC NORMALLY CLOSED
NO NORMALLY OPEN
NaOH SODIUM HYDROXIDE
EtOH ETHANOL

Atlantic Richfield Company

ASB TREATMENT SYSTEM
PROCESS FLOW DIAGRAM
Leviathan Mine Site
Alpine County, California

FIGURE 7



Explanation

———	Roads
———	Streams
HDPE	High-Density Polyethylene
ASB	Aspen Seep Bioreactor
▲	Sample Point

APPROXIMATE SCALE IN FEET
0 200

NO.	DATE	BY
-	1/21/2013	AMEC

ASB TREATMENT SYSTEM SLUDGE
REMOVAL ACTIVITIES LAYOUT
Leviathan Mine Site
Alpine County, California

Atlantic Richfield Company

Figure 8